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ABSTRACT

Northwest Regional Educational Laboratory's (NWREL) Research Evaluation Program provides assistance to educators based on its research, development, testing, and training activities concerning new methodologies for educational evaluation. This report describes the assistance provided to educational practitioners in 1984 through support materials, consultation, and direct training. New method assistance focused on microcomputer use in evaluation; several publications were provided. A number of aids were provided to practitioners interested in cost analysis and in policy analysis. Training programs focused on microcomputer use in evaluation and cost analysis. Over 150 pages of this document are divided among four appendices: (1) Cost Communiques, a NWREL newsletter describing research in cost analysis; (2) materials for a workshop using microcomputers in evaluation and assessment; (3) visual aids to accompany a presentation on microcomputers; and (4) materials and visual aids for a cost analysis workshop. (GDC)

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paper and report series

No. 105 METHOD ASSISTANCE REPORT

Peter J. Burry

Research on Evaluation Program

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No. 104 METHOD ASSISTANCE REPORT

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November 1984

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PREFACE

The Research on Evaluation Program is a Northwest Regional Educational Laboratory project of research, development, testing, and training designed to create new evaluation methodologies for use in education. This document is one of a series of papers and reports produced by program staff, visiting scholars, adjunct scholars, and project collaborators--all members of a cooperative network of colleagues working on the development of new methodologies.

What types of assistance have been provided by the Research on Evaluation Program during 1984? This report reviews the activities related to new methods assistance, cost analysis assistance, policy analysis assistance, and training and training materials.

Nick L. Smith, Editor
Paper and Report Series

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METHOD ASSISTANCE REPORT

Over the history of the Research on Evaluation Program (ROEP), an extensive variety of methods for conducting evaluation studies has been assembled. These methods have been drawn from an array of areas outside educational research and evaluation. During 1984 part of the Program's scope of work was to provide assistance to people in the field in using the methods previously developed.

In order to efficiently use the resources available to the Program, two types of approaches were implemented to provide assistance. One was the development of an Annotated Bibliography of Practitioner Aids developed by the Research on Evaluation Program (January 1984). The bibliography contains brief descriptions of over 40 reports, checklists, bibliographies, and other materials specifically intended for use as aids in planning, conducting, and reporting evaluations. This bibliography was used to inform potential users of the availability of aids for the evaluation practitioner. Summaries of requests for the aids under new methods assistance, cost analysis assistance, and policy analysis assistance are provided in those sections of this report.

The second approach to providing assistance was a series of training sessions. These were held to provide direct assistance to practitioners, as described in the training section of this report. The materials used in these sessions may be found in the Appendices. Based on this work, a series of guides will be finalized in 1985 (interim drafts of the first ten guides appear in Report No. 101); the guides will be used to provide continued assistance to practitioners.

New Method Assistance

The category of new methods covers a variety of topics which have been the focus of previous Program efforts. Chief among them is the use of microcomputers in evaluation.

Microcomputers

As shown in Table 1, 98 requests have been made for practitioner aids related to microcomputers. Two of these aids (accounting for 67 requests) were produced during 1984.

The following are brief descriptions of the 1984 practitioner assistance studies and aids related to microcomputers.

No. 94, Computers Plus: The Organization, Operation, and Evaluation of an Intensive Summer Program Designed to Develop Computer Literacy Among Educators
Authors: P. J. Gray and J. Tafel; January 1984, 48 pages

How should workshops to increase the computer literacy of teachers and administrators be designed, organized, and operated to meet the increasing needs of diverse students? This report describes one series of four summer courses developed to provide introductory students with basic concepts, hands-on computer experience, practice in software evaluation, and assistance in planning for microcomputer use. The report has been produced to provide one model for meeting the current high demand for such workshops.

No. 95, Computer Use Planning: A Case Study of a School District's Long Range Planning Efforts
Authors: P. J. Gray and L. J. Rawers; May 1984, 53 pages

How do school districts form policies about the instructional and administrative uses of computers? How do school policy-forming committees function, and how can their operations be made more effective? These and related questions are addressed in this case study of one district's initial attempts to establish policy about the use of computers in the schools. This report focuses on the operations of the policy formation committee, its composition, activities, and products. An analysis of this case example is used as a basis for recommendations about how other districts can better develop computer policies.

No. 98, Microcomputers and Evaluation Research: Potential Benefits and Problems
Author: P. J. Gray; May 1984, 15 pages

What are the applications that might be made of microcomputers in evaluation, and what are the kinds of problems (personnel, organizational and technical) that must be overcome if microcomputers are to be used effectively? These questions are addressed in this brief introduction to the use of microcomputers in evaluation work.

Table 1

New Methods Assistance Requests
Microcomputer Aids

Report No.	Title	No. of Requests
76	Open-ended Checklist for Evaluation of Microcomputer Software	6
89	Microcomputer Workshop Materials	14
91	Guide to Use of DB MASTER	11
94	How to Develop an Intensive Computer Literacy Program for Educators	9
98	Microcomputers and Evaluation Research: Potential Benefits and Problems	58
	Total	98

Aids on Other Topics

Report No.	Title	No. of Requests
61	Bibliography of Evaluation Utilization	1
74	Management Consulting Case Study	1
75	Public Data Bases	3
78	Document Analysis Exercises	1
96	Evaluation Units in State Departments of Education: A Five-Year Update	9
99	Foundation Support of Evaluation	8
	Evaluation Contracting Checklist*	2
	New Techniques for Evaluation**	3
	Total	28

*Informal documents
**Program-produced book

No. 101, Guides to Evaluation Methods[1]
Editors: P. J. Gray and J. F. Turnidge; September 1984, 146 pages

This report contains interim drafts of ten guides designed to acquaint evaluators with new tools for using cost analysis, microcomputers, investigative methods, and other approaches in evaluation. These guides are based upon previous Program research and publications, and will be distributed as individual documents upon final revision.

Four of the guides produced by the Program were converted into articles and published as part of an ongoing column, Microcomputers and Evaluation, in Evaluation News. The topics covered by these articles were word processing, data base management, statistical analysis, and the evaluation of professional software. In this form they received wide dissemination.

Other Topics

Table 1 also shows that 28 requests were made for practitioner aids on topics other than microcomputers (e.g., management consulting, document analysis). Several of these topics appeared in Program products developed during 1984, including new support materials for using investigative methods, product evaluation techniques, and hearings approaches in evaluation (see Report No. 101). The following are brief descriptions of other 1984 new method resources.

No. 96, Evaluation Units in State Departments of Education: A Five-Year Update
Author: N. L. Smith; May 1984, 12 pages

How have the evaluation units in state departments of education changed in the last five years? Have there been changes in their staffing patterns and in the nature and amount of their work? Answers to these and related questions are provided in this report which summarizes the results of two surveys (one in 1978, the other in 1983) which investigated the nature of state department evaluation operations. The report ends with information on the projected needs of these evaluation units over the next few years.

No. 99, Foundation Support of Evaluation
Author: N. L. Smith; August 1984, 31 pages

A computerized search of the Foundation Grants Index was conducted to identify the nature and extent of foundation awards for evaluation work. The awards granted between 1972 and 1983 are described here in terms of size of grants, nature of recipients and supporting foundations, yearly and geographic distribution patterns, and topical areas of primary support. Because so few awards were found, three follow-up questions are also addressed. What is the actual level of foundation activity in evaluation? How public is foundation work in evaluation? and To what extent is foundation evaluation activity accurately represented in the Foundation Grants Index? Foundation resource materials are also summarized.

No. 101, Guides to Evaluation Methods
Editors: P. J. Gray and J. F. Turnidge; September 1984, 146 pages

This report contains interim drafts of ten guides designed to acquaint evaluators with new tools for using cost analysis, microcomputers, investigative methods, and other approaches in evaluation. These guides are based upon previous Program research and publications, and will be distributed as individual documents upon final revision.

No. 102, Finding the Questions for Evaluation Research
Author: J. T. Dillon; October 1984, 31 pages

Evaluation research can be conceived of as a question-answering process, and its resulting knowledge conceived of as a question-answer proposition. The theoretical study of questions suggests four practical strategies for undertaking an evaluation study. (1) Before identifying the question to investigate, classify the questions that can be asked. (2) Before posing the question, analyze it. (3) Before addressing the question, construct a dummy answer. (4) Before stating the answer, state the questions. In general, it makes pragmatic sense to expend at least as much effort on finding the question as on finding the answer.

Cost Analysis Assistance

One of the major topics of interest among both regional clients and NWREL staff is cost analysis. The Research on Evaluation Program has been conducting work on this method for several years. Over the past years there have been several reports on cost analysis in the Program series, such as "Manual

for Cost Analysis in Educational Evaluation" by Levin and Seidman (ROEP Paper and Report Series No. 65, November 1981), and "Multiple Alternatives Modeling in Determining Fiscal Roll-backs during Educational Funding Crises" by Wholeben and Sullivan (ROEP Paper and Report Series No. 70, March 1982), as well as a variety of support materials and workshops.

Building on this background of experience and expertise, the Program developed several practitioner aids in this area. In addition, as will be reported later, a number of training sessions were conducted on cost analysis.

Table 2 shows that 410 requests were made for past and current practitioner aids related to cost analysis. The following are brief descriptions of 1984 cost analysis products.

No. 100, Cost Analysis in Educational Evaluation
Authors: N. L. Smith and J. K. Smith; September 1984, 51 pages

What kinds of cost analysis studies are being done in educational evaluation? The educational literature shows very few applications of cost methods, especially the seemingly most appropriate method: cost effectiveness analysis. The health literature shows a greater use of cost methods, but for treatment or intervention research rather than for program management purposes as in education. An examination of a contracting firm's cost studies revealed the use of only the simplest cost methods and those for management purposes. A national study of SEA evaluation units showed an increasing mandate for the use of cost methods and a movement toward the use of somewhat more complicated procedures. An interpretation of these findings using knowledge transfer theory shows that practitioners have little problem with the credibility and relevance of cost methods but have major difficulties in understanding and implementing them.

No. 101, Guides to Evaluation Methods
Editors: P. J. Gray and J. F. Turnidge; September 1984, 146 pages

This report contains interim drafts of ten guides designed to acquaint evaluators with new tools for using cost analysis, microcomputers, investigative methods, and other approaches in evaluation. These guides are based upon previous Program research and publications, and will be distributed as individual documents upon final revision.

A newsletter, Cost Communique, is another Program resource on cost analysis. This newsletter informs Northwest Regional Educational Laboratory staff about cost analysis procedures, methods, resources, and studies. Three issues were published in 1984, with a circulation of 75 per issue. As a result, a total of 225 copies of the Cost Communiques shown in Appendix A were distributed.

Table 2

Cost Assistance Aids

Report No.	Title	No. of Requests
82	Cost-Analysis Case Studies	2
85	Cost-Analysis Technical Research Report	5
86	Alternative Teacher Preparation Programs: A Cost-Effectiveness Comparison	5
87	Proceedings of a Seminar on Cost Analysis	3
88	Cost Analysis Bibliography	55
	Cost Effectiveness Checklist*	1
	Introductory Discussion of Cost Analysis*	31
	Cost-Effectiveness: A Primer**	83
	CO$T Communique***	225
	Total	410

*Informal documents
**Program-produced book
***Periodic program newsletter

Policy Analysis Assistance

Policy analysis has been identified as a critical area for decision makers to become familiar with. Over the last several years, the Program has developed a number of practitioner aids in policy analysis. As shown in Table 3, 80 requests were made for these resources, two of which were developed in 1984. These two aids describe methods for conducting policy analysis studies on the topic of microcomputer use, a problem area of policy analysis. Following are brief descriptions of the two aids.

No. 95, Computer Use Planning: A Case Study of a School District's Long-Range Planning Efforts
Author: P. J. Gray and L. J. Rawers; May 1984, 53 pages

> How do school districts form policies about the instructional and administrative uses of computers? How do school policy-forming committees function, and how can their operations be made more effective? These and related questions are addressed in this case study of one district's initial attempts to establish policy about the use of computers in the schools. This report focuses on the operations of the policy formation committee, its composition, activities, and products. An analysis of this case example is used as a basis for recommendations about how other districts can better develop computer policies.

No. 97, Policy Analysis: A Tool for Setting District Computer Use Policy
Author: P. J. Gray; May 1984, 23 pages

> How can policy analysis procedures be used to help school districts set policy on computer use? This report addresses that question by discussing the steps in the policy formation and implementation processes, outlining how policy analysis methods can contribute to the creation of effective policy.
>
> Published in Educational Leadership, October 1984.

Training

Two topics were the focus of training for practitioners by Program staff: one is microcomputer use in evaluation, and the other, cost analysis.

Table 3

Policy Analysis Assistance Aids

Report No.	Title	No. of Requests
69	The Use of Assignment and Transportation Models in Evaluation	1
70	Multiple Alternatives Modeling in Determining Fiscal Roll-Backs During Educational Funding Crises	2
73	MICROPIK: A Multiple-Alternatives, Criterion-Referenced Decisioning Model for Evaluating CAI Software and Microcomputer Hardware Against Selected Curriculum Instructional Objectives	2
83	A Primer on Decision Analysis Procedures	2
92	Dimensions of Moral and Ethical Problems in Evaluation	21
95	Computer Use Planning: A Case Study of a School District's Long-Range Planning Efforts	40
97	Policy Analysis: A Tool for Setting District Computer Use Policy	12
	Total	80

Microcomputers

Four training sessions were held on microcomputers in evaluation during 1984. One occurred at an invitational conference sponsored by the Washington Educational Research Association. Some 50 participants were involved in that session. Training topics included the use of word processing, data base, statistical analysis, and other programs in evaluation. The materials for that workshop may be found in Appendix B.

A second training session occurred at the Education Commission of the States' Large Scale Assessment Conference. This session reviewed the uses of microcomputers in evaluation and described the important concepts related to the evaluation of

microcomputers for instructional purposes. The presentation materials used for this session are in Appendix C. Twelve people attended the session.

The third training session was an introduction to microcomputers in evaluation research conducted at Evaluation '84, the joint annual meeting of the Evaluation Network and the Evaluation Research Society. A fourth training session involving a software information exchange also took place during Evaluation '84. A total of 50 people attended these two sessions.

Cost Analysis

Six events provided training experiences for practitioners on cost analysis topics. One was a workshop attended by 15 Colorado educators held in cooperation with the Northern Colorado Board of Cooperative Educational Services.

There were also three workshops sponsored by the Chapter 1 Technical Assistance Program at the Laboratory. These were conducted by an RMEP staff member using Program developed materials. A total of 52 people attended these sessions (25 in Arizona, 12 in California, and 15 in Washington). The workshop materials used in these sessions are in Appendix D.

The last two cost-related events involved the presentation of papers on practical topics at Evaluation '84, the joint annual meeting of the Evaluation Network and the Evaluation Research Society. These sessions, attended by 70 people, addressed the topics of "Economists' and Evaluators' Perspectives on Cost-Outcome Analysis: A Call for Convergence," and "The Use of Cost Analysis in Health Evaluations: A Review of the Literature."

Summary

In summary, several hundred contacts were made with practitioners during 1984. These contacts were through providing support materials, consultation, and direct training. These assistance activities were conducted as a means of service delivery as well as a way to field-test and refine the evaluation approaches and support materials being developed by the Program through its other 1984 research and development activities.

Footnote

1 It should be noted that Report 101, Guide to Evaluation Methods, appears in several of the lists. The reason for this is that guides in the report cover microcomputer, cost analysis, and other topics.

APPENDIX A

Cost Communiques

CO$T COMMUNIQUE No. 4, February 1984

* *

NWREL COST STUDY WINS NATIONAL AWARD

A study titled "Alternative Teacher Preparation Programs: A Cost-Effectiveness Comparison" by Nick Smith (NWREL) and Jon Denton (Texas A&M University) has received the Assocation of Teacher Educators' 1984 Distinguished Research Award. The study, described in the last issue of the CO$T COMMUNIQUE, concerns two questions, (1) which of two existing secondary education teacher preparation programs is more effective in preparing students to teach, and (2) when program costs are considered, do the increased student performances warrant the differential increase in costs?

The full report is No. 86 in the Research on Evaluation Program Paper and Report Series.

COST ANALYSIS FOR EDUCATIONAL ADMINISTRATORS

A recent article by Jana Kay Smith and Nick Smith has appeared in the School Information and Research Service Bulletin (SIRS). Using a conversational tone, the authors introduce administrators to four common cost-analysis methods, and provide examples to illustrate that these techniques, as applied to the evaluation of instructional programs, are much more straightforward and understandable than they first appear.

The four formal cost-analysis methods seen as having the greatest usefulness in education are cost-feasibility, cost-utility, cost-benefit, and cost-effectiveness analyses. The first method, cost-feasibility analysis, is useful for determining whether a program is affordable within budgetary constraints. The last three methods enable one to combine outcomes with costs to determine the most cost-efficient program. Smith and Smith first discuss each cost-analysis method and then apply it to the same hypothetical educational problem to help highlight the differences in the methods.

In summarizing their article, the authors suggest that the cost-feasibility methods should be used when determining whether a program is economically feasible under budgetary constraints. No outcome data are taken into account using this method, and consequently there is no evidence to suggest which program is more effective. Cost-utility analysis goes one step beyond cost-feasibility and adds estimates of program outcomes. Because the outcome data are estimated rather than actually measured, however, the reliability of the analysis can be questioned, although it may be helpful in planning situations. Cost-benefit analysis places a dollar figure on program outcome which is then compared to the cost of the program. It is often difficult to value educational outcomes in dollar terms and, as a result, the usefulness of

this method is generally limited to vocationally-oriented instructional programs. Finally, cost-effectiveness analysis involves collecting data on program effects using traditional evaluation measures. These measures are then compared to the cost of the alternatives. Cost-effectiveness analyses are appropriate for evaluating programs with identical or similar outcome measures.

The authors recommend cost-effectiveness analysis, of the four techniques, as the best method for use in the full evaluation of alternative instructional programs. Only for programs like vocationally-oriented interventions designed to improve student marketability or job performance would cost-benefit analysis be the preferred method.

In conclusion, Smith and Smith point out that the differences between the four major types of cost-analysis methods are clear and easy to understand. Although conducting a cost analysis study can require considerable time, effort, and expertise, it is stressed that administrators already have a sufficient understanding of the basic approaches to consider using formal cost studies in their own work.

ASPECTS OF MEASURING COST EFFECTIVENESS IN EVALUATION TECHNICAL ASSISTANCE EXPLORED

Gary Estes' 1983 paper presented at the annual meeting of the American Educational Research Association focused on the issues which need to be considered prior to promoting "cost-effectiveness" strategies for evaluating Chapter 1 Evaluation Technical Assistance Centers (TACs). Estes makes the emphatic point in the paper that a need exists to be explicit about desired outcomes, costs for providing services, and the relationship between costs and outcomes.

Decisions about "cost-effectiveness" should be based on a close examination of (1) where resources are allocated or used, (2) the specified outcomes, and (3) the hypothesized relationship between the inputs and outcomes. For example, in regard to Chapter 1 evaluation technical assistance, the workshops, consultations, phone calls, and so on may be considered input since all of the TAC's resources are used to provide these services. The cost ingredients list regarding inputs includes: personnel, travel, phones, materials, facilities, indirect cost and fees, and other costs such as client travel and outside consultants. The anticipated effects of these expenditures, as defined by the goals of Chapter 1 evaluation technical assistance, might be defined as (1) the number of Chapter 1 reports submitted, (2) the quality of the data in these reports, (3) the utility of evaluation results in making local decisions, and (4) client satisfaction regarding the services provided. However, as Estes reports, specific effects/outcomes and criteria for judging the magnitude of these effects are not clear.

In the absence of clear criteria for these effects, previous studies evaluating the cost-effectiveness of TACs have defined effects as the number of services provided (e.g., workshops, consultations), as the number of clients served, or as the number of client contact hours. Such studies substitute as the criteria for judging cost-effectiveness, the easily quantifiable means of providing service (i.e., consultations, workshops, etc.) or, at best, the nominal effects of service (i.e., clients served and contact hours) in place of the true goals of evaluation technical assistance. He states that these criteria could easily be viewed as input measures rather than as effects or outcomes.

Estes lists six additional criteria that represent the goals of technical assistance as: number of reports turned in to the states by districts; number of districts included in the state report; number of instances in which services result in program modification or in a particular evaluation approach being used; extent of client satisfaction with TAC services; amount of local capacity built; spin-offs such as better tests or testing practices, and other programs using materials or ideas. He goes on to say that the number of reports and the number of districts are quantifiable and could be collected. It is also possible that the number of instances of service impact or the extent of client satisfaction could be quantified albeit with greater effort and possibly less reliability. Other criteria might also be scaled and collected.

Estes provides an extensive example of how one might determine cost-effectiveness if workshops, consultations, phone calls, etc., were viewed as the inputs for producing effects which were measured by criteria related to the goal of getting clients to attempt a process evaluation using a handbook. Such an approach would provide much needed information.

In conclusion, he notes that: (a) it is critical to be informed with data about where and how costs are distributed for a program; (b) an explicit agreement on the effects and criteria for effects is necessary if a program is to know how to place priorities among goals and objectives; (c) using information from (a) and (b) in making programmatic decisions will improve efficiency in accomplishing goals; (d) like evaluations, cost-effect studies will be only one piece of information which is used in decisions to continue, discontinue, or modify a program.

More information about "Cost-Effectiveness in Evaluation Technical Assistance: Different Aspects of Measuring Cost and Outcomes," may be obtained from Gary Estes, Director, Evaluation and Assessment Program.

TAC ACTIVITY INCREASING IN THE AREA OF COST ANALYSIS

The Chapter 1 Evaluation Technical Assistance Center (TAC) has recently engaged in three activities aimed at improving cost-analysis skills among Chapter 1 personnel.

- Cost-Analysis Workshop Offered
  In December 1983, a cross-section of Chapter 1 teachers and administrators, state and federal Chapter 1 evaluators, and Bureau of Indian Affairs personnel, were provided with an introductory workshop on cost analysis methods. The workshop was intended to introduce basic cost analysis concepts, provide a structured forum for exploring the possible advantages of cost studies, and help participants select appropriate cost methods. Participants reportedly appreciated the workshop, especially the use of the ingredients approach to identifying program components. Additional cost analysis workshops are being planned to help Chapter 1 staff apply cost-analysis methods to specific Chapter 1 problems. Readers can learn more about the TAC cost-analysis workshops by talking with Jana Kay Smith, Technical Assistance Center.

- Using Microcomputers as Tool for Cost-Analysis and Cost-Modeling Studies
  The use of spreadsheet programs such as Multiplan and integrated software such as Lotus 1-2-3 are being considered in conducting cost-related sensitivity analyses. These programs offer a powerful way to test the implications of changing cost values and assumptions. A practical application of these tools is in the assessment of national Chapter 1 cost and participation data. They may also be used to develop models which allow for different interpretations of the results of cost studies. For example, the effects of the following factors on the results of cost studies may be modeled using microcomputer-based spreadsheets and database programs: (a) different scaling properties of outcome data, (b) violations of scaling assumptions, (c) varying sample sizes, (d) different rates of inflation, and (e) price adjustments. Readers can learn more about the use of microcomputers as tools for doing cost-analysis and cost-modeling by talking with Steve Murray, Technical Assistance Center.

- Evaluation Technical Assistance Staff Given Inservice on Cost-Analyis

  In October 1983, two training sessions were held for staff from the Region 2 Technical Assistance Center, representatives from the United States Department of Education. One session focused on cost-analysis as applied to Chapter 1 programs, while the other session addressed the issue of the cost-effectiveness of TACs. As a result of the session, Region 2 is considering a needs assessment of SEA and LEA evaluators regarding their interest in cost-analysis training and technical assistance. For more information about other TACs' activities in the area of cost-analysis, contact Steve Murray, Technical Assistance Center.

COST STUDY OF LOCAL SCHOOL DISTRICT'S INSTRUCTIONAL MANAGEMENT PROGRAM PROPOSED

A proposal for doing a cost study of a computer-based instructional management system is currently being developed. The proposed study would assess the cost-effectiveness of a system which provides computer-generated printouts to teachers for the purpose of planning and monitoring students' programs. The system is based on computer scored and/or recorded tests and the resulting reports generated by the computer. A design combining cost-feasibility and cost-utility elements is being proposed since the data needed to conduct cost-effectiveness or cost-benefit studies are not available. The cost ingredients of the system have been identified as (1) cash costs such as teacher aides, data processing, and the program coordinator, and (2) non-cash costs such as teacher and school level administrator time. The value of the outcomes of the system (i.e., instructional management information) will be assessed by having teachers, principals, district administrators, and other staff "spend" a hypothetical "budget" of $100, $1,000, or $10,000 on various outcomes. For more information on this proposed study, contact Bill Savard, Evaluation and Assessment Program.

SHARE YOUR COST RELATED WORK

If you are engaged in any studies, technical assistance, or other activities that involve cost analysis, share your insights, problems, or results with CO$T COMMUNIQUE readers by letting Peter Gray (ext. 387) know.

CO$T COMMUNIQUE is a periodic internal publication from the Research on Evaluation Program, Northwest Regional Educational Laboratory. Questions concerning CO$T COMMUNIQUE should be directed to its editor: Peter J. Gray (extension 387).

* *

FOUR DIFFERENT APPROACHES TO COST ANALYSIS

Cost analysis as envisioned in this newsletter can be a formal or an informal activity based on academic cost analysis techniques or on practical budgeting and accounting methods. As we reflect on our experiences in confronting cost related problems in school districts and other real settings, it is clear that in many cases formal techniques are more appropriately seen as hueristic devices rather than as prescriptive procedures. This newsletter is dedicated to the recognition that costs play an important role in program evaluation.

In this issue, four practical uses of cost analysis are described. Three of them are related to Chapter 1 technical assistance work and the other is related to a program evaluation contract with a school district.

The first Chapter 1 example demonstrates microcomputer based analyses of comparative cost effectiveness data. The microcomputer is shown to be a valuable and powerful tool for cost analysis. The second Chapter 1 example concerns the relationship between changes in funding at the national level and the extent and type of services provided to Chapter 1 students. The relationships demonstrated have evaluative implications, but the analyses do not fall precisely under any of the four cost analysis methods, namely, cost feasibility, utility, benefit, and effectiveness. Nonetheless, they are valid uses of cost analysis concepts. The third Chapter 1 example describes a workshop on cost analysis that is currently being offered for school administrators. Its purpose is to help them apply streamlined cost analysis techniques to everyday problems. The final example of cost analysis concerns the cash and non-cash costs associated with a computer based instructonal management system. In this case, cost data are used to illustrate where program improvement may most appropriately focus.

ANALYZING COST EFFECTIVENESS VIA MICROCOMPUTER

Chapter 1 projects may have many different configurations in regard to the use of aids, materials, and other resources. Various configurations may result in different start up and operational costs, average normal curve equivalent (NCE) gains, and cost effectiveness ratios. Steve Murray has developed the following tables to illustrate how presenting data about these resulting factors in varying formats can help one interpret the cost effectiveness of different Chapter 1 programs.

SUMMARY OF PROJECT COST AND OUTCOME INFORMATION
Sorted by Project

	Comparable Cost Per Student			Pre-test	Post-test	Outcome	
Project	Acquistion	Operational	Total	NCE	NCE	NCE Gain	C/E Ratio
A	$20	$410	$430	23.6	37.2	13.6	$32
B	$60	$340	$400	28.4	42.0	13.6	$29
C	$30	$130	$160	36.5	50.6	14.1	$11
D	$20	$130	$150	23.6	32.3	8.7	$17
E	$40	$380	$420	36.6	50.0	13.4	$31
F	$20	$220	$240	28.5	37.2	8.7	$28
G	$30	$140	$170	28.5	34.7	6.2	$27
H	$60	$160	$220	40.8	55.8	15.0	$15
I	$20	$120	$140	36.6	44.0	7.4	$19
J	$20	$230	$250	40.9	50.0	9.1	$27
K	$90	$350	$440	40.9	50.2	9.3	$47

SUMMARY OF PROJECT COST AND OUTCOME INFORMATION
SORTED BY COSTS

	Comparable Cost Per Student			Pre-test	Post-test	Outcome	
Project	Acquistion	Operational	Total	NCE	NCE	NCE Gain	C/E Ratio
I	$20	$120	$140	36.6	44.0	7.4	$19
D	$20	$130	$150	23.6	32.3	8.7	$17
C	$30	$130	$160	36.5	50.6	14.1	$11
G	$30	$140	$170	28.5	34.7	6.2	$27
H	$60	$160	$220	40.8	55.8	15.0	$15
F	$20	$220	$240	28.5	37.2	8.7	$28
J	$20	$230	$250	40.9	50.0	9.1	$27
B	$60	$340	$400	28.4	42.0	13.6	$29
E	$40	$380	$420	36.6	50.0	13.4	$31
A	$20	$410	$430	23.6	37.2	13.6	$32
K	$90	$350	$440	40.9	50.2	9.3	$47

SUMMARY OF PROJECT COST AND OUTCOME INFORMATION
SORTED BY NCE GAIN

	Comparable Cost Per Student			Pre-test	Post-test	Outcome	
Project	Acquistion	Operational	Total	NCE	NCE	NCE Gain	C/E Ratio
H	$60	$160	$220	40.8	55.8	15.0	$15
C	$30	$130	$160	36.5	50.6	14.1	$11
B	$60	$340	$400	28.4	42.0	13.6	$29
A	$20	$410	$430	23.6	37.2	13.6	$32
E	$40	$380	$420	36.6	50.0	13.4	$31
K	$90	$350	$440	40.9	50.2	9.3	$47
J	$20	$230	$250	40.9	50.0	9.1	$27
F	$20	$220	$240	28.5	37.2	8.7	$28
D	$20	$130	$150	23.6	32.3	8.7	$17
I	$20	$120	$140	36.6	44.0	7.4	$19
G	$30	$140	$170	28.5	34.7	6.2	$27

SUMMARY OF PROJECT COST AND OUTCOME INFORMATION
SORTED BY C/E RATIO

	Comparable Cost Per Student			Pre-test	Post-test	Outcome	
Project	Acquistion	Operational	Total	NCE	NCE	NCE Gain	C/E Ratio
C	$30	$130	$160	36.5	50.6	14.1	$11
H	$60	$160	$220	40.8	55.8	15.0	$15
D	$20	$130	$150	23.6	32.3	8.7	$17
I	$20	$120	$140	36.6	44.0	7.4	$19
G	$30	$140	$170	28.5	34.7	6.2	$27
J	$20	$230	$250	40.9	50.0	9.1	$27
F	$20	$220	$240	28.5	37.2	8.7	$28
B	$60	$340	$400	28.4	42.0	13.6	$29
E	$40	$380	$420	36.6	50.0	13.4	$31
A	$20	$410	$430	23.6	37.2	13.6	$32
K	$90	$350	$440	40.9	50.2	9.3	$47

The general format of each of the preceding tables is the same. That is, they each represent a summary of project costs and outcome information. The project code letters are listed down the left side of the table followed by the comparable cost per student in the form of acquisition, operational, and total costs. Next, the average pre- and post-NCE score and NCE gain for each project is listed. Finally, in the far right column the cost effectiveness (C/E) ratio is shown. This ratio is the result of dividing the total cost per student of each project by the average NCE gain. What differs in the four tables is the way the data for the projects are sorted.

Using a microcomputer based spreadsheet program like SuperCalc or an integrated program like Lotus 1-2-3, it is possible to enter the data needed to set up the first table where the projects are simply listed in alphabetical order. This layout is useful in that it is relatively easy to find a particular project, but it is not so easy to compare projects in terms of total cost, average NCE gain, or C/E ratio. With programs like 1-2-3 and SuperCalc, one can sort the data used to set up the first table by these other areas. The resulting formats are shown in tables 2, 3, and 4. Using these tables one can easily find the programs that are least expensive, have the greatest NCE gains, and/or achieve the lowest C/E ratio. The advantage of using a microcomputer for such analyses is that once the data are entered, the generation of any of a variety of tables is left up to the software program and no additional work is required of the user except to specify the type of ordering to be performed. This is far less labor intensive than having to hand-type each new table.

In addition to being a convenient way to organize the presentation of comparative cost data, the microcomputer can also help one to better understand the limitations of cost effectiveness comparisons. Using another set of data, Steve Murray has produced the following table to show how sample size and the related margin of error in NCE gains can influence cost effectiveness estimates.

The implications of using different estimated gains (low, middle, and high) based on the error associated with different sample sizes are worth noting. Using the low cost effectiveness estimate (i.e., cost per student/ reported NCE gain + NCE error) the projects fall into the following order: B ($67), A ($87), C ($92), E ($111), D ($130). The same order is obtained using the middle estimate (i.e., the one listed in the table): B ($111), A ($133), C ($167), E ($175), D ($225). However, using the high cost effectiveness estimate (i.e., cost per student/ reported NCE gain - NCE error), the order of most cost effective to least cost effective program changes entirely as follows: A ($286), B ($316), E ($422), D ($844), C ($913). Clearly, one should consider the effect of measurement error when comparing programs' cost effectiveness.

For more information on the use of microcomputers in doing the kinds of analyses shown in these tables and on their implications, contact Steve Murray, extension 404.

COST-EFFECTIVENESS ANALYSIS WORKSHEET

	Program A	Program B	Program C	Program D	Program E
Total Costs	$20,000	$20,000	$20,000	$20,000	$20,000
Number Served	20	40	30	10	15
Cost Per Student	$1,000	$500	$667	$2,000	$1,333
NCE Gain	7.50	4.50	4.00	8.90	7.60
Sample(N)	16	30	24	6	13
Cost-Effectiveness (Low)	$87	$67	$92	$130	$111
Cost-Effectiveness (Mid)	$133	$111	$167	$225	$175
Cost-Effectiveness (High)	$286	$316	$913	$844	$422

NCE Error: $N(6) = \pm 6.53$; $N(13) = \pm 4.44$; $N(16) = \pm 4$; $N(24) = \pm 3.27$; $N(30) = \pm 2.92$.

TRENDS IN TITLE I/CHAPTER 1 FUNDING AND SERVICE LEVELS

The recent changes in authorizing legislation, from Title I to Chapter 1, and the change in the overall appropriation to school districts have heightened interest in federally funded compensatory education. However, the sources of information useful in tracking such changes are often used in isolation from one another. And to date there are no comprehensive summaries of the various sources of information. As a result, the picture of what is happening in Chapter 1 is fragmented at best.

A paper presented by Steve Murray at the Spring Conference of the Washington Educational Research Association aggregates existing data sources to address two policy questions of interest at the local, state, and federal levels. These questions are:

1. How has the national funding level for basic Title I/ Chapter 1 grants to districts changed since 1979-80?
2. What are the associated national trends in Title I/ Chapter 1 participation?

The paper is a working document. It is suggestive rather than definitive; it outlines areas for study rather than closing off study.

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Murray summarizes the conclusions of this paper under the following three topics:

> Funding level: When corrected for inflation (using annual increases in teacher and instructional aide salaries paid), dollars appropriated to districts declined each year from 79-80 through 82-83 with a slight increase in 83-84. By 83-84, the cumulative effect of appropriations from 79-80 amounted to a 28.1% reduction in support for Chapter 1 programs.
>
> Participation from 79-80 through 81-82: Overall, the number of students served dropped by 9.9%. However, in the aggregate, districts have tended to reduce services disproportionately in high priority areas (e.g., reading and mathematics programs and elementary programs). The proportion of students receiving services in more than one program area may have also dropped slightly.
>
> Funding and Service: The number of students served relates, on the average, to the overall budget cut. By adjusting for inflation and improving the validity of the data on students served, the relationship is closer to proportional than using the more superficial measures. Moreover, analyses show that using superficial indicators of funding and service underestimates the impact of budget cuts on Title I/Chapter 1.

Murray states that the data are equivocal regarding the question as to whether the changes in funding and service suggest more or less efficient programs. He points out that the reduction in the number of students served from 79-80 to 81-82 was somewhat greater than the reduction in appropriations before correction for inflation. While this might seem to suggest less efficiency, correcting for inflation depicts what could be the opposite trend of increased efficiency.

Noted in the paper are two reasons to be suspect of either conclusion. First, dollars appropriated, whether or not corrected for inflation, do not match dollars available for a given year as funds can be carried over or reallocated from the prior year. Adjusted dollars appropriated, thus, can be a misleading measure of support. It is reasonable to expect some school administrators to use carry-over to buffer significant cuts. The net effect of this carry-over management would be to delay or mask the effects of budget cuts. A second reason for not concluding that the schools were less efficient in 81-82 is the use of participant count as a measure of service level.

In addition to possible changes in reporting practice from year-to-year, there is a more significant problem in using an aggregate count of participation as a measure of service level. Namely, there is no reason to expect the cost of services per student to be equal across categories of service or even across time. In other words, a count can have

different cost implications depending on the program, the service area, and the year in which the count is taken. A 1976-77 study of compensatory education program costs found, for example, that Title I reading programs required about 1.6 times more financial support than did Title I mathematics programs in grades 1-6.

In general, this paper highlights the difficulties of using national data collected for differing purposes to answer specific cost questions. Murray does an excellent job of pointing out possible interpretation of the data while adding important cautions.

COST ANALYSIS WORKSHOP

A workshop on cost analysis for school administrators has been developed which provides an introduction to four cost analysis methods. This workshop teaches skills needed for selecting the most appropriate cost analysis method to use in the evaluation of an educational program. Developed by Jana Kay Smith, this cost analysis workshop has been conducted in educational agencies in Arizona, California, and Colorado.

The three-hour workshop begins with a discussion of the rationale for conducting cost analysis studies. The participants are introduced to potential applications of cost analysis methods, beginning with a discussion of eight common questions that can be answered by these methods. These are questions often asked by administrators, program coordinators, program participants, and even members of the community. For example, community members may ask, "What are we getting for our tax money?"

Once the purpose of cost analysis methods in educational evaluation is made clear, four methods, cost feasibility, cost utility, cost benefit, and cost effectiveness are defined in everyday terms. For example, the participants are encouraged to imagine themselves on a car lot looking at new pickup trucks. They are given the scenario that they have saved $6000 to buy a new truck (and don't want to use credit). They see Truck A for $5500 and Truck B for $7500. Which purchase is feasible within their financial constraints and which is not? Obviously, it is feasible to purchase Truck A. This is an example of cost feasibility reasoning.

Suppose, however, the participants wanted to go beyond feasibility and try to get the most for their money? If they were in farming and wanted the truck to haul hay, they might look at the power of the trucks. In this case, Truck A will haul up to 3 tons of hay, while Truck B will haul up to 9 tons of hay. By comparing the cost of the trucks to their hauling effectiveness, you can see that it will cost $1,833 (5500/3) to haul a ton of hay with Truck A, compared to only $833 (7500/9) to haul a ton of hay with Truck B. Clearly, Truck B is the most cost effective selection.

After the participants understand the difference between the four cost analysis methods, examples of applications of these methods to educational evaluation are described. A flow chart is used to delineate the steps of method selection.

The workshop concludes with a discussion of methods of "streamlining" the steps of valuing ingredients and measuring outcomes. For each step, a minimum of four streamlining techniques are offered. For example, in some cases, only the largest ingredients might be listed, or already collected measures of outcomes may be used. The effect of each streamlining technique on the reliability and validity on the study is emphasized and participants are encouraged to consider adopting any of the streamlining techniques only with caution.

Development of the workshop was funded by the Region 4 Chapter 1 Technical Assistance Center and the Research on Evaluation Program. For more information about the cost analysis workshop, contact Steve Murray.

PROGRAM EVALUATION/COST ANALYSIS COMPLETED

Bill Savard has completed a study of the costs and associated effects of a math and reading objectives based instructional management system. The intent of the study was to provide information to school district decision makers regarding the system. A major portion of the study dealt with finding out the feelings about the program on the part of the people associated with it (including teachers, principals, and aids). In general, the program has the support of most of those involved, although approximately 60% of the regular teachers and 44% of the Chapter 1 teachers see problems with it at present.

These results suggest that the system should be retained but that changes should be made. Cost data were reviewed first to determine whether the cost per student for the system was reasonable and second to determine what monetary impact changes might have. Costs were broken out item by item to determine per child costs.

In order to calculate per child costs, Savard used the average daily membership (ADM) figure of 8,587 for 1982-83, for grades 1-6, supplied by the district. Average daily membership is usually higher than average daily attendance (ADA) but lower than total enrollment and perhaps provides the most realistic base for calculating per child costs. The overall per child cost was $55.62. Of this amount, approximately $1.66 is attributable to the district office, $48.06 to the school level, and $5.90 to data processing. Within the data processing costs, $.70 per child was for paper, forms, answer sheets and other supplies. Within the school level, cost was $12.06 per child for aides and $31.23 for teacher time.

Examination of the various cost categories reveals that some can be described as cash costs, others as non-cash costs. Cash costs can be defined as being directly attributable to the program and which could reasonably be expected to be saved if the program were eliminated. Non-cash costs are defined as being either directly or indirectly attributable to the program, but which could not be reasonably expected to produce cash savings if the program were eliminated.

In summary, it would appear that the system costs about $477,644 per year. About a third of that, $151,149, is made up of cash costs. This amounts to about $17.60 per child. The other two-thirds of the total consists of non-cash costs, costs which would remain even if the program was eliminated. Several non-cash cost categories were identified that deserve particular scrutiny, including district office staffing (perhaps not enough), principals' time (perhaps not enough), and teacher time (perhaps not used efficiently). Making changes in such non-cash cost areas would not result in budget increase.

Savard has effectively united program evaluation and cost analysis into a synergistic whole. This has been achieved by looking not just at the reasonableness of the costs of the system but also at the cash and non-cash costs of the system and then relating these to potential modifications of the system suggested by input from those associated with it. For more information about this study, contact Bill Savard, extension 342.

CO$T COMMUNIQUE is a periodic internal publication from the Research on Evaluation Program, Northwest Regional Educational Laboratory. Questions concerning CO$T COMMUNIQUE should be directed to its editor: Peter J. Gray (extension 387).

* *

Three studies are reported in this issue of the CO$T Communique. The first is a study of state education agency (SEA) evaluation units regarding their past, present, and anticipated future uses of cost methods. The second is a similar study of local education agencies (LEA). Both of these studies were conducted by the Research on Evaluation Program. The third study focused on alternative Chapter 1 elementary reading programs. It was conducted by the Assessment and Evaluation Program.

SEA STUDY

Of the 50 state departments of education contacted in this study, only 37 had centralized evaluation units in 1983 and 29 of them (78%) responded to our questionnaire. Although a few evaluation units had done as many as a dozen cost studies in the past five years, the mode was clearly zero. Single program cost descriptions and cost-feasibility analyses were the most commonly done studies. Although the number of studies done was low and the methods used were relatively simple, the units doing cost studies reported being pleased with the impact of their efforts.

Surprisingly, 48 percent of the units said there was currently a formal expectation or requirement that they do some form of cost analysis work and they estimated devoting an average of 11.5 percent of their budgets to cost work. Fifty-nine percent of the units anticipated having a formal requirement to do cost studies in the next five years and expected to spend an average of 17 percent of their budgets for that purpose.

When we asked why the units were not currently doing more cost studies, some respondents said that they were simply not being asked to do them. Most respondents, however, said that it was difficult to relate cost data to educational outcomes and that they had few examples, texts, or guidebooks to follow in conducting cost studies.

The evaluation units did expect to be using a wider range of cost methods in the future, especially cost-utility analysis and cost-feasibility analysis. Few of them expected to be using the more complicated methods which include actual comparisons of costs with outcomes, such as cost-effectiveness and cost-benefit analysis.

When we asked why they didn't use cost-effectiveness analysis more (the theoretically best method for this work), they reported either not knowing much about it or thought it was simply too complicated.

For more information, contact Nick Smith, Research on Evaluation Program.

LEA STUDY

Of the 67 metropolitan school districts surveyed in this study, 52 (78%) completed the questionnaire. Most evaluation units had had some experience with cost analysis methods, particularly with cost descriptions and cost feasibility analyses. Although, in general, the number of studies done was low and the methods used were relatively simple, the units doing cost studies reported being pleased with the impact of their efforts.

At the time of the survey, 21 percent of the units said there was currently a formal expectation or requirement that they do some form of cost analysis work, and they estimated devoting an average of 3.3 percent of their budgets to cost work. When asked to project future requirements to conduct cost analysis work, 71 percent anticipated having a formal requirement to do cost studies, and expected to spend an average of 9 percent of their budgets for that purpose. Clearly, the respondents anticipate conducting more cost studies in the future.

The impediments or problems in conducting cost analysis studies were also investigated. It was evident that as experience increased (measured as total number of cost studies conducted in the past 5 years), the impediments or problems in implementing cost studies decreased. Since the number of cost studies conducted by school districts is expected to increase over the next few years, we would expect evaluators to have fewer problems in doing cost studies.

For more information contact Nick Smith, Research on Evaluation Program.

ALTERNATIVE CHAPTER 1 PROGRAMS

This study concerned an evaluation of three alternative remedial reading programs used at the intermediate level in Chapter 1 programs. Three elementary schools were involved in the study. The three instructional programs were: 1, computer assisted instruction; 2, computer managed instruction; and 3, an individualized instructional program guided by reading specialist without use of computer technology. A cost benefit study was commissioned to determine the relative merits of the three instructional approaches.

The purpose of the study was to document the relative costs, utility, and benefits to identify which program provides the greatest benefit per dollar. In this instance, the effectiveness in increasing student achievement was equal for the three programs, while the costs varied a great deal. On this basis alone the traditional program was the most desirable. Other utility considerations such as curriculum alignment and skill mastery rates suggest that the computer managed instruction program was also worth further consideration.

The computer assisted program is effective and received good ratings of quality and utility. Unfortunately, it is both costly and has poor alignment with the district's adopted reading curriculum. Other evaluation information, such as student attitude, was not collected for this study, which might have supported the program. This study illustrates the breadth and depth of information that can be added to an evaluation through cost analysis methods.

For more information contact Steve Nelson, Assessment and Evaluation Program.

EDITOR LEAVES

With this issue of the CO$T Communique I leave the Laboratory to assume the position of Associate for Evaluation at Syracuse University. Please feel free to contact me at:

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CO$T COMMUNIQUE is a periodic internal publication from the Research on Evaluation Program, Northwest Regional Educational Laboratory. Questions concerning CO$T COMMUNIQUE should be directed to Program director Nick Smith (extension 384).

APPENDIX B

Microcomputer Workshop Materials

MATERIALS FOR A WORKSHOP ON USING MICROCOMPUTERS IN EVALUATION AND ASSESSMENT*

INTRODUCTION

The purpose of this workshop is to introduce participants to the many and varied uses of microcomputers in evaluation. Microcomputers may be thought of as very powerful all purpose tools. They can be of benefit at every stage of the evaluation process. As shown in the figure below, they can be used from proposal writing and planning to reporting.

The diversity of software programs which have specific uses is what makes microcomputers so versatile. With word processing programs a computer can be used to create, edit, and print textual material. With electronic spreadsheets and statistical programs computers can be used to record, manipulate, analyze, summarize, and report numbers. With graphic programs computers can be used to commmunicate information in visually attractive and understandable ways.

Each of the major types of programs listed below is described in this booklet. Those descriptions consist of a discussion of the concepts related to each program type, a sample of representative commercially available programs, and a list of references for more information.

SUMMARY OF EVALUATION USES OF MICROCOMPUTERS

Activities	Word Proces.	Data Bases	Test Genera.	Calc/ Stats	Graphic Present.	Telecom/ Network.
Proposals & Planning	X	X		X	X	X
Management	X	X		X		X
Data Collection		X	X			X
Data Analysis		X		X		X
Reporting	X				X	X

*Adapted from Research on Evaluation Report No. 89 of the same title by Peter J. Gray and Dennis Deck, Northwest Regional Educational Laboratory, Portland, Oregon, November 1983.

WORD PROCESSING

The main concept behind word processing is the notion of a document, that is, a letter, book chapter, entire report, proposal boiler plate, or any discrete body of textual information. The creation of such a document starts with the use of a keyboard, more or less like a standard typewriter, to enter the text into the word processing system. Formatting, editing, merging, and printing are the four things that a word processor has to offer in addition to simple typing of text.

Formatting

There are some features of word processors which help to arrange words on a page as a document is created. Formatting refers to the arrangements of the words themselves. Like a typewriter, a word processing program allows you to indent the first word of a paragraph or to tab the headings and subheadings of an outline. It is possible to automatically center headings. Whole blocks of text can be indented and single spaced. In fact, the spacing between lines can be altered by using the return key just like on a typewriter. In addition, some word processors allow automatic underlining, subscripts, and superscripts. Special features include the creation and editing of multi-columns of text or tabular information and the creating of footnotes.

Editing

Once text has been entered, extra letters, words, and so on, can be inserted or deleted without having to retype the surrounding text. The word processing program automatically rearranges the text to accomodate these changes. In fact, words, phrases, sentences, and whole blocks of text may also be moved from one part of the document to another if the order of things needs to be changed.

Another interesting feature of most word processing programs is the ability to search for a particular word, such as one that may have been consistently misspelled. With most word processors it is possible to automatically replace one word with another one, such as the correct spelling of a misspelled word, wherever it occurs.

There are even programs called spelling checkers which are electronic dictionaries. They "look at" each word in a document and check to see if it matches the words in the dictionary. If not, the word is presented for a decision about its correctness. Still more sophisticated are programs that check for diction, style, and clear wording such as the one being developed by Bell Laboratories.

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Merging

Since word processed documents are stored electronically, it is usually possible to combine them in various ways. The simplest way is to attach one document to another. For example, the parts of a proposal that were created as separate documents can be linked with a standard institutional description and disclaimers without having to retype or cut and tape them into place. Whole letters may be built of smaller blocks selected from a variety of paragraphs that provide different options for reporting results to various audiences. Old text may also be merged with new text as when a standard letter is customized by adding a unique beginning and ending, or by searching and replacing a symbol (such as "**") with the name of a particular person. In this way, names, addresses and text can be merged to produce personalized form letters.

Blank forms such as activity logs can also be created and stored. They may be retrieved and completed for individual events and then stored again. At the end of a project the logs may be printed to document the activities which took place.

Printing

Some of the formatting features described above may have already set the general layout of a page, but with many word processors, final choices are made at the time of printing as to where the text is to appear on the printed page.

The first concept here is margin, that is, the blank space at the top, bottom, left, and right of the words. In most word processing programs you set the margins at values which are used most commonly (for example, letters or manuscripts), and only make changes for special cases (for example, outlines). When printing a document one must also decide if the text is to be right justified, that is, whether the words are to line up on the right side of the page in a straight line as they do on the left side of the page.

Headers and footers which do not appear in the text may be added at the time of printing. Page numbers may also be added automatically at the top or bottom of the page by the program as the document is being printed.

Spacing between the lines of text is often chosen at the time of printing (i.e., single space, double space). It is also possible to adjust the number of lines of text on a page, or to put it another way, to decide where each page stops, so that there are no widows or orphans at the top or bottom of a page.

In summary, word processing programs provide flexibility in the organization of text from its initial typing, to editing, to merging with other text, to printing.

A Sampler of Word Processing Programs

The programs presented in the following table are just a sample of the nearly 100 word processing programs available. There are many competitors, especially at the middle and upper price ranges. The articles in the reference list provide detailed evaluations of programs in terms of their specific features.

Program	Company	Cost	System	Comments
Bank Street Writer	Bruderbund	$70	Apple	The Volkswagon of word processing programs. This menu driven program is ideal for draft production and other every day uses.
Pie Writer	Hayden	$150	Apple	Has many features of more sophisticated programs, but it takes some practice to be able to use them all.
Electric Pencil	IJG Computer Services	$86	TRS-80	Like Pie Write, a good low cost system. This one for TRS-80 machines.
WordStar	Micro Pro	$495	CP/M IBM	The top of the line program with most of the features of professional word processors.

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DATA BASE MANAGEMENT

A microcomputer data base may be thought of as an electronic filing system. Like a paper filing system, a data base consists of a consistent set of records. Each record is a completed form and on each page of the form there is specific information. The items of information on the page are called fields. For example, the first page of a student data base might have fields which contain an identification number, the student's last name, first name and middle initial, the student's grade, teacher, and school, sex and racial data, and any other demographic information needed. The second page of a student data base may have a set of test scores over a number of years. The third page may have parent information, such as parents' names, work and home addresses, and so forth. Together, the completed pages of this form make up one student record, and all of the student records created using this form constitute a file.

Let's look at the general characteristics of data base management programs.

Function:	Facilitates the storage, retrieval, and reporting of information
Programs:	PFs File, DB Master, dBase II
Advantages:	Handles many kinds of information Very flexible - can be used to create many different files (e.g., student records, personnel records, equipment inventories) Easy to maintain information by editing, deleting, updating, sorting, and indexing records Can be used to retrieve information about individual records or about groups of records meeting certain criteria
Disadvantages:	Requires considerable time to set up Requires time to learn the operation of the more complex programs Limited statistical analysis Requires trained personnel to maintain the data base

There are three sets of concepts related to data base management that will help you understand what data bases are and what they do. One set concerns setting up a file. Another set has to do with how to use a data base management system. And the third set concerns generating reports.

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Setting up a file

There is a considerable amount of planning that has to be done so that (1) the creation of a data base can be accomplished in an efficient manner and (2) the data base will have maximum utility. The first step is to decide how the file is to be organized; that is, what the primary key is to be. The primary key has the same relationship to a data base that a main entry card catalog has to a library. The "records" in the library are organized by some shelf location code. This code consists of an indicator for the subject area, a code for author's last name, the publication date, a title code, the copy number, and so forth, until that "record" is uniquely identified. Similarly, the primary key is a code for each record in a data base. It may be as simple as a Social Security number or it may be more complex and, for example, consist of last name, first name, and birth date.

It is often the case that records are not entered in primary key order. For example, the students in grade one may be entered after the students in grade five, even though their identification numbers come earlier in the sequence. The primary key is used by the program to find each record. The shorter the key, the quicker the program will be able to operate. Of course, there are many ways to organize the records in a data base. In fact, they may be sorted according to any of the fields in a record. These other organizations are called secondary keys and are very helpful if the user wishes to review a group of records organized in a particular way, say, by zip code and in alphabetical order by parent's last name.

Once the primary key has been established, the next step is to lay out the rest of the fields in a record. These can be alphabetic, numeric, or special fields, such as yes/no, social security, telephone, date, and so on. The fields or a record should be organized into logical sets and may be allocated to separate pages if necessary. The final step in creating a data base is to determine the format which will insure its utility.

In many cases the data base will be created as you specify the fields on each page of the form. Therefore, it is important to have a good idea of the physical layout of the screen pages, the basic characteristics of each field (i.e., the type of information and the amount of space to be allocated to it in the data base), and the special characteristics of each field (e.g., primary key, computed). Then you can follow the program directions on the actual setting up of the data base.

Using a data base

Once a file has been created it may be put to many uses. The initial use is to add records. When this choice is made, the program will typically display a blank first page of the data base form. The user simply begins entering the information field by field. Let's look at a couple of ways to save time when entering information into a data base.

There are times when you will not want to enter all of the information in a data base at once. An example might be when the test scores from the second year of a five-year program are ready. It would be a waste of time to have to move page-by-page and field-by-field through a form to get to the appropriate place. Instead, it is possible to extract just those fields needed to identify each record (i.e., the primary key) and those fields that need to be changed and to put them together into an abbreviated form. When data are entered and saved, they are inserted into their proper place in the larger record.

Another way to speed data entry is to use default values. These can be specified at the time when the data base is first created. Default values are those that will be used again and again, for example, a particular telephone area code. In other cases, temporary default values might be specified when a set of records are being added, for example, all of the reading scores for the third-graders in Crest Drive School. A good data base management program will facilitate the entry of data by allowing you flexibility in formatting the pages in your form, by giving you the option of creating short forms, and by providing you with the ability to set both permanent and temporary defaults.

After records have been entered, it is then possible to search for a particular record or a given set of records. In some programs, an extensive list of options for searching the data base is available. For example, you may wish to search for records which fall within a certain range such as Aa to Cz. Or there may be a need to find all of the records which start with a particular prefix, such as NWRELXXXXX. Sometimes records with a particular string of letters or numbers are desired, as in a search for all of the materials which include the word microcomputer. When the exact spelling of a word is not known, a search can be conducted which will find any word that has all the letters except the unknown ones (e.g., GR?Y). All of the relational signs can also be used to direct a search, including: =, <, >, and their various combinations.

Often these different types of searches can be linked together by an AND or an OR condition. For example, you might want to specify two discontinuous ranges. In this case you would simply indicate the first range and then link it to the next one with an OR statement.

Having found an individual or group of records, it is then possible to edit or delete them. Deleting simply removes the record from the data base. Of course, you must be sure that you want the record deleted. It is often a good idea to have archive files of old versions of a data base with records that have since been deleted, just in case you wish to retrieve them at some later date.

Editing a record means correcting, updating, or adding information. Using a short form is a convenient way to edit records. For example, a short form that just has grade level, new classroom assignment, and end of the year test scores can be used to quickly update student records. Often you may want to send the edited record directly to a printer so that you have a typed copy. There are, however, more sophisticated ways to print out the infomation in a data base.

Printing Reports

Generating an interesting and informative report is one of the most exciting and rewarding uses of a data base management system. There are four different formats that have to be specified in creating a report, namely, page format, data format, sort format, and select format. They form the column headings for the following table with their respective sub-formats falling under each heading.

Page Format	Data Format	Sort Format	Select Format
page numbering	comment lines	sort fields	record chacteristics
report dating	column titles	subtotal break fields	(range, includes,
lines/page	computed fields	page break fields	starts with,
continuous/ single sheet	data fields	(column totals)	relationals,
lines between records	comment fields		AND / OR conditions)
labels	horizontal sub- & grand totals		
	record numbering		
	code fields		
	report width		

Creating a good report takes as much planning as setting up the data base to begin with, but once it is created you can use it and/or its parts again and again.

Summary

Data base management packages are one of the more useful tools available in the microcomputer toolbox. A good strategy for developing an understanding of how these programs work is to start with a simple one like VisiFile or PFS File. As you gain experience in designing more demanding data base applications, you will outgrow these programs and look for a package with the extended capabilities you now need.

To design an application, try the following process:

1. Determine your goals. Be clear about what you want to accomplish with the data base.

2. Specify the data needed. Sketch the types of reports you expect from the data base. Develop a list of needed fields. Consider the requirements of each field.

3. Design the reports. Refine the sketches of reports and layout on graph paper.

4. Set up the data base. Enter the data base as you have designed it. Enter some sample cases and format some simple reports.

5. Revise. Learning from your initial mistakes, start over with an improved design. Repeat as necessary. Now format the standard reports you designed.

6. Pilot test. Use the data base on real data for a period of time. Manually confirm that the results are correct. Plan on revising again.

Three planning aids are attached at the end of this section: data base planning checklist, data base estimation worksheet, and a summary of software specifications.

Available Software

There are perhaps a hundred different data base management programs available on the market, ranging in price from ten dollars to over a thousand. Obviously, all data base programs are not created equal. It is useful to distinguish between three types of programs: file management programs, true data base systems, and text-oriented data base programs.

File management programs can only access information from a single file at a time. This is fine for a simple mailing list but not for an accounting system that must keep vendor information in one file and detailed information about specific orders in another. These programs are typically easy to learn and use but are limited in the amount or type of information they can store.

On large mainframe computers, data base programs must be able to access the information you want, even if the data are maintained in different files. For example, the request "please list the addresses of students who were in Chapter 1 last year and scored below the 35th percentile" would require data from an address file, a Chapter 1 participation file, and a test score file.

File management and data base programs usually limit the size of a field to less than 256 characters or the record to less than 1000 characters. That is adequate for most applications, but not if more than a sentence is required for any one field. A text-oriented data base allows fields to be a single word or a whole page. It is usually possible to search the data base on key words. These data bases are well suited for maintaining research notes, observations of students or staff, or bibliographies.

Some popular programs include:

Program	Vendor	Cost	System*	Type	Comments
Visifile	VisiCorp	$250	Apple	file management	easy to use but limited capabilities
PFS File PFS Report	Software Publishing	$125	Apple IBM	file management	easy but limited, need both programs
DBMaster	Stoneware	$230	Apple IBM	file management	many features but a little difficult and tedious to use
Infostar	MicroPro	$500	CP/M IBM	features of both	sophisticated data entry and report generation features
dBASE II	Ashton-Tate	$700	CP/M IBM	database management	great flexibility with built-in language, programming skills recommended
Datafax	Link Systems	$250	Apple IBM	text oriented	easy to use, free form input like a manual filing system

* Apples and certain other microcomputers can run CP/M software with the addition of a special circuit board.

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INSTRUMENT GENERATION

A good instrument generation program should have the following characteristics:

- easy text entry and editing for item creation and modification
- convenient and safe data storage so that items can be quickly manipulated and reliably saved
- simple item retrieval to facilitate the development of a complete instrument
- flexible printing options for generating instruments, including last-minute editing of items, as well as the creation of headings and special directions

Text Entry

Flexibility in text entry is the key characteristic that a program needs in order to ease the task of developing items. A good program will allow both immediate modification of items and modification subsequent to their creation. Modification might include altering an item by:

- inserting or deleting material
- reformatting
- adding options (i.e., responses)
- changing the item's descriptors

These characters facilitate the continuing improvement of items throughout the life of an item bank.

Another important aspect of flexible text entry is the variety of item formats that are allowed. For example, programs differ in their ability to handle true/false, multiple choice, matching, fill-in-the-blank, or essay items.

In addition to item type, the provisions made by a program for the inclusion of pictorial material is one that must be considered if such material is critical to the nature of an item. Pictures, diagrams, formulas with subscripts and superscripts, and special symbols are almost impossible to save in machine-readable format. About the only ways to overcome this limitation are (1) for a program to allow one to add a reminder to an item that pictorial material is to be included at the time

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of printing, and (2) for the program to allow designation of the number of line feeds to follow an item so that room is provided for the material.

Item Storage and Manipulation

Safe item storage is related to a program's ability to verify new material before it is written to disk and to check before items are saved to insure that another set with the same name is not inadvertently destroyed.

There are two ways to handle the storage and manipulation of test items. One way is to allow the creation of a large number of items, limited only by the capacity of the auxiliary storage medium, such as floppy disk drive. In this case, items are manipulated by transferring as many as possible to random access memory (RAM) and gradually working through the item bank. The drawback here is the time needed to transfer items back and forth from auxiliary storage to RAM.

The other way to store and manipulate items is to limit each file to as many items as will fit in RAM at one time. This makes for faster manipulation of a given set, but, of course, the set is smaller than a file whose size is related to disk capacity. And, if items from separate sets scattered throughout a disk are to be manipulated, then the task can be even more time consuming than a similar task performed with a program which is based around disk storage limits.

Some programs that are RAM based provide for the merging of subfiles into larger units, and for breaking bigger files into smaller ones. This can facilitate the task of manipulating a given set of items.

Item Retrieval

The simplest method of retrieving items is to assign each one a number as it is created. Then, using a master printout, one can locate and call up each item by its number in response to a prompt provided by the program. Another way is to be able to display items on the screen in numeric order and to be able to press a single key to identify an item to be selected. For large item banks, the use of item descriptors can help to narrow down the number of items to be reviewed in order to identify those to be selected. For example, descriptors might refer to (1) type of item (i.e., item format), (2) subject matter, or (3) classification in relation to a taxonomy (e.g., Bloom's taxonomy).

In some programs, the answer line can be used not only for storing the specific answer to an item, but also for information that can be used to help find items. For example, the following might be stored in the answer line:

key words in an essay, notes to oneself or any alphanumeric information, or if the items are based on a set of objectives, the abbreviated name or number of the objective tested by the item.

Another piece of information that would be useful in retrieving appropriate items for a given instrument is an indication of item difficulty. This could be accomplished by simply placing in the answer line a rating of "easy," moderate," or "hard." A more sophisticated method would be the ability to include both difficulty and discrimination indexes for all item alternatives. Using a sort routine, items could then be selected on index values, as well as information on content, format, and other characteristics.

This inclusion of specific information useful for item retrieval adds a whole new dimension to instrument-generation programs.

Printing

Once items are retrieved from the bank for a particular application, it is helpful if they can be edited to tailor them to that setting. It would also be useful to have the option of saving the edited items in a separate file for later use. In any case, the original set of items in the item bank itself should not be permanently altered by these last-minute modifications. This is especially important if the item bank is intended to be generic; for example, if it is a set of essay items on current events where the details of the items are to be added in relation to the latest happenings.

In addition to editing capabilities, a useful program will allow one to format an instrument to a particular situation. Using special headings or titles is one way to accomplish this. Being able to tailor the instructions can greatly improve the utility of an item bank, too. The capability to determine left and right margins, to determine the number of lines of print and total numbers of lines per page, to require a pause after each page is printed, and to print all or just part of a test are all program print features that can help improve the face validity of an instrument.

Summary

Programs exhibit these characteristics to varying degrees. Trying different programs is the only way to determine if the features you need are included and readily usable.

Instrument Generation Sampler

Program/Company	Cost	System	Comments
Author I Radio Shack Education Division	$150	TRS-80 I/III	Test assembly, on-line testing, and the development of student records/profiles are features of this program
The Learning System, Microlab Highland Park, Illinois	$150	Apple	On-line testing of items from a program item bank, class statistics and student profiles are all part of this program.
Test Bank 2.1 Advanced Technology Applications San Diego, CA	$450	TRS-80 I/III	Flexible text entry, item editing, test preparation are just some of the features of this program
Teacher Utilities Vol. 1 Minnesota Educational Computing Consortium (MECC)	$37	Apple II	Item files, on-line testing, test assembly, test printing, plus class statistics and grades are features of this program.

ELECTRONIC SPREADSHEETS

Some say that the electronic spreadsheet in the form of the first VisiCalc program is what started the microcomputer revolution, and particularly the Apple computer. With this very basic tool, a microcomputer can be used to do anything that it is possible to do by hand using a multi-column ledger page. For example, spreadsheet programs can be used to:

> prepare a budget, make an income tax projection, calculate cash flow, do cost analyses, determine overhead allocations, generate sensitivity analyses, calculate weighted averages, prepare statistical summaries, analyze survey results, prepare bid specifications, keep track of study participants, and more.

In a few short years spreadsheets have grown from not much more than electronic ledgers to programs that include present value function, linear programming, and calculus functions. They also are likely to be able to read data from files created by other programs, such as accounting applications or data bases.

Integrated programs are often build around a sophisticated spreadsheet. One form of integration is the program that includes spreadsheet, graphics, and word processing programs all in one super program. Examples of this type of program are MBA (Context Management System; Torrance, CA), and 1-2-3 (Lotus Development; Cambridge, MA). Companies like VisiCorp provide compatibility among the different programs in their line, such as VisiCalc, VisiFile, and VisiPlot so that data can be shared among these separate programs. A new development is the integration of spreadsheet and data base management programs such as LogiCalc (Software Products Int'l; San Diego, CA). In trying to decide among different approaches to integration, one must consider both the quality of the individual programs and the ease with which data can be transfered.

Examples

The examples on the next several pages illustrate what the VisiCalc program can do.

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WHAT CAN VISICALC DO?

CALCULATIONS

Like a calculator, VisiCalc excels at performing calulations (adding, subtracting, multiplying, dividing). In the example below, someone enters the number of students participating in a Chapter I program in the shaded area. The VisiCalc worksheet totals the number of students at each grade and in each subject area.

NUMBER OF CHAPTER I STUDENTS

Grade	Read	Math	Total
2			0
3			0
4			0
Total	0	0	0

NUMBER OF CHAPTER I STUDENTS

Grade	Read	Math	Total
2	23	14	37
3	35	27	62
4	25	23	48
Total	83	64	147

RECALCULATION

Unlike a calculator, VisiCalc can easily recalculate the results when any value is changed. In the example below, we reduce the FTE for Denison to try to reduce the project total to a more reasonable figure. VisiCalc immediately recalculates the totals using the new value for FTE.

PROJECT STAFF BUDGET

Staff	FTE	Salary	Benefit	Total
Jones				5670
Denison				15270
Williams				5670
Clark				16680
Faddis				15270
Total Salaries and Benefits				58560

PROJECT STAFF BUDGET

Staff	FTE	Salary	Benefit	Total
Jones	.5	9450	1890	5670
Denison	.5	12725	2545	7735
Williams	.5	9450	1890	5670
Clark	1.0	13900	2780	16680
Faddis	1.0	12725	2545	15270
Total Salaries and Benefits				51025

TABLE LOOKUP

Often we have to look up values in a table (e.g. test score, salaries, bonus points) before doing a computation. VisiCalc can do the table lookup for us. In the example, we enter a code and the worksheet looks up the proper points and computes the total.

Activity	Bonus code	Bonus points
Books read	1	10
Participation	2	20
Extra report	3	40

Student	Test	Hawk	Bonus code	Total
Janice A				87
Dennis B				104
James B				44
.				
.				

DATA STORAGE

Information can be stored on floppy disks for later use. In the example below, program expenditures are added to a VisiCalc template each month. The computer recomputes the Year-To-Date Expenditures and Percent of Budget Expended.

PROGRAM EXPENDITURES COMPARED TO BUDGET

Act #	Account	Budget	YTD Expend	% of Budget	SEP	OCT	DEC	JAN
100	Salaries	56000	14000	25				
200	Benefits	14500	3625	25				
300	Pch serv	1200	800	67				
400	Supplies	1800	2100	117				
500	Outlay		0	0				
600	Other		0	0				

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LOGICAL DECISIONS

Often we want to do a computation only if some condition is true. For example, we will consider students eligible for a special program only if their test score or grade point is above or below some criterion. The worksheet below marks a student as eligible for Chapter I services only if the test score is below the cutoff.

Chapter I Student Selection Worksheet

Cutoff on test: Reading 35
Math 39

Student	Read Score	Math Score	Reading Eligible	Math Eligible
Janice A	[redacted]	[redacted]	*	
Dennis B				*
James B			*	*
.				
.				

SIMPLE GRAPHICS

Do you ever tire of reading tables of numbers? VisiCalc can help by constructing simple bar graphs. Here we enter numbers in a graphing worksheet which rescales and displays the results.

MIGRANT STUDENT ENROLLMENT BY MONTH

Month	Enrollment
Sept	*********
Oct	**********
Nov	******
Dec	**
Jan	**
Feb	**
Mar	*****
Apr	**********
May	**********

Advanced Spreadsheet Features

Recent spreadsheet programs provide extended features that are not available with the original VisiCalc. The table below suggests some features to look for in the new generation of spreadsheet programs such as Multiplan, SuperCalc2, and Advanced VisiCalc.

Feature	Description
Consolidation	Allows worksheets to be linked together (e.g., Years Summary worksheet accesses totals from 12 Months Summary worksheets). Makes the spreadsheet seem three-dimensional.
Sort	Allows the rows or columns to be sorted in numeric or alphabetic order (e.g., reorder list of students from lowest test score to highest for selection purposes).
Execute	Executes a series of commands from a command file that you have created (e.g., load a worksheet, print the results, change a value, print the new results).

Spreadsheet Program Sampler

Program	System	Comments
VisiCalc	Apple II TRS-80 II, III Atari Commodore Pet IBM	The first spreadsheet program, very popular.
Advanced VisiCalc	Apple III	Includes a number of advanced features over VisiCalc.
SuperCalc	CP/M IBM	Similar to VisiCalc with some minor improvements
Multiplan	CP/M IBM magazine	Called software package of the year by Infoworld

Note: CP/M stands for microcomputers using the CP/M operating system, (Control Program for Microcomputers). Most business-oriented microcomputers, such as TRS-80 Model II, NorthStar Advantage, DEC Rainbow, Osborne I, and Xerox 820 fall into this category. Also note that an Apple II with a Z80 softcard can use CP/M software.

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STATISTICAL ANALYSIS

At the heart of all evaluation and assessment efforts is the analysis of data. Statistical analysis programs on main-frame computers have provided the main statistical source of support over the last 25 years. Accessibility to mainframe systems and their steadily increasing costs, together with the rapid advance of mini- and microcomputer technology, has begun to change that picture! Recently microcomputer based programs, ranging in price from $20-$2,000 have become available. Of course, they vary greatly in their features.

There are 5 sets of features that should be examined when considering the purchase of a microcomputer based statistics program. The first is documentation. This includes the written information about how to use the program and about the technical aspects of the program. The second feature is data management, including data entry and editing. The third feature concerns the statistical manipulation of data in terms of descriptive and inferential statistical procedures. A fourth feature is the printing of information. Included here is the simple printing of raw data and the generation of complete reports. There is a fifth, general feature which might be termed special capabilities, such as the availability of a random sampler and the extent to which the program can be configured to a particular system. Each of these features is examined in more detail in the following discussion.

Written Information

The documentation for a program can be a major factor in facilitating or hampering its use. Good documentation for statistical software will at least provide some description of (1) the way the software is organized, (2) some basic information about each feature of the program, and (3) more detailed information about the statistical procedures and when different procedures might be selected. Welcome additions are a set of examples on a tutorial to show how to use each program feature and the results obtained, and examples showing what printed versions of the results will look like from a simple printing of cases to finished reports.

Exemplary documentation will include the particular algorithm used in each analysis so that the user can be fully aware of its assumptions. The best documentation will also provide instructions for modifying formulas to better meet particular situations.

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Data Management

Data management starts with the entry of data into the program. Some programs provide the option of entering data either directly from the keyboard or from a data disk.

A very elementary question to ask about a statistical program is what kind and how much data can it handle? For example, can one enter integer, alphanumeric and/or decimal data? And what is the total number of variables and the number of cases that are possible?

Two data entry procedures exist, case-by-case entry, where all variables for each case are entered at the same time, and variable-by-variable entry, where all cases for each variable are entered as a group. Better programs give you a choice between these two procedures.

If it is possible to enter data from another disk, one must know if data from a data disk needs to be formatted in a way unique to the program, or if data formatted in a standard way, such as DIF files, are acceptable. If DIF files are acceptable, then data can be shared with such programs as VisiCalc and DB Master. It is also important to know if data are stored in sequential files or random access files, and if conversions are possible, because of the different ways these files are accessed.

Once data are in the program, there should be procedures for maintaining them. At a basic level, maintenance includes adding new data, correcting erroneous data, and deleting unnecessary data. There are some programs which allow transformations by constants, exponentials, ranking, and so on. Being able to add new data can help to make a statistical program more like a data base management program, since the features can be used to build a record regarding a given case or a particular variable.

Statistical Procedures

Programs vary in the range of statistical procedures they include and in the variety of procedures regarding any one type. The following list is a sample of the range and variety of procedures that may be offered:

Descriptive Statistics

- Frequency
- Mean
- Median
- Mode
- Range
- Standard deviation

Measures of Relationship
- Correlation (e.g., Pearson product-moment correlation co-efficient)
- Contingency tables/cross-tabs
- Linear regression

Distributions used in statistical Inference
- Normal
- Chi
- F
- t

Analysis of Variance (ANOVA)

- One Way (Fixed effects)
  - equal N's
  - unequal N's
- Two Way (Fixed effects)
  - equal N's
  - unequal N's
- One way and multifactor analysis of variance
  - randomized designs
  - factorial designs
  - split-plot (mixed) designs

Not all programs contain all types of procedures, and some include different specific procedures within a type. Therefore, it is especially important to examine statistical packages in light of your specific needs and preferences before purchase.

Printing

There are times throughout the process of using a statistical program that printing may be desired. When data are being entered, for example, one may wish to get a printed case-by-case or variable-by-variable summary in order to verify the accuracy of the data. Printed results of computations, especially of intermediate processes such as a regression equation, which may be used in other computations, can be helpful. And, of course, the results of analysis should be printable in a format that is consistent with conventions (e.g., contingency table, ANOVA table) and should be clearly labeled so that one can easily interpret them.

Beyond the printing of individual results, it is often useful to present a graphic picture in the form of scatter plot, histogram, and so on. These may then be combined with the results of

analysis to form a report. For example, a report summarizing an item analysis might have the following information:

- item analyzed
- number of respondents
  - number checked
  - number selected
- number selecting each response
- percentage selected regarding this response
- percentage answering this response
- totals for each of the above
- no answers
- median value
- average value
- standard deviation
- a histogram of responses

When looking at report generation features, one should seek the kind of flexibility offered by the best data base management and survey development programs. That is, a program should allow control over (1) placing headings and footnotes on a page, (2) formatting the arrangement of textual and other information, and (3) storing completed reports for later use.

Sampler of Statistical Analysis Programs

The listing of computer statistical aids which appear at the end of this section summarize some of the current programs. It is vitally important to review first-hand any of the programs listed in this section. In fact, a good way to find a reliable vendor is to inquire about preview privileges and technical support. A 30-day trial period to assess the quality of a program should be allowed before making a final decision. During that time frequent interaction with either the local dealer or developer will indicate the quality of support available.

With this experience, you and your staff can gain confidence in the performance of a piece of software and in the technical support available as backup.

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The American Statistician, February 1983, 37(1), 83-86.

A LISTING OF MICROCOMPUTER STATISTICAL AIDS

The listings below have been adapted from The American Statistician, Feb. 1983, Vol. 37, No. 1, pp. 83-86. (NK = "Not Known".)

Package Name & Aprx.$	Vendor	Description	Language and System
Abstat $395	Anderson-Bell 5336 S. Crocker Littleton, CO 80120	Data Manipulation editing, regression, ANOVA, Cross-tab, chi-sq, histograms, plots, descriptive, tests, others	NK CP/M IBM
AIDA $235	Action-Resrch. Northwest 11442 Marine View Dr. SW Seattle, WA 98146	Histograms, ANOVA descriptive, bivariate multivariate, tests correlations, regression, plots, transformation, weighting	Basic Apple
A.STAT $125	Rosen Grandon Assoc. 296 Peter Green Road, Tolland, CN 06084	Transformations, descriptive, frequencies, tables, regression	Basic CP/M Apple PET
Curve Fitter ^35	Interactive Microware, Inc. PO Box 771 Dept. SK State College PA 16801	Best fit, scales, average, smooth, interpolate, least squares	NK Apple
DAISY $80	Rainbow Computing, Inc. 19517 Business Center Drive, Northridge, CA 91324	Descriptive, regressions, transforms, tests, ANOVA, nonparametric, time series, modeling, plots	NK Apple
Dynacomp Reg-$119 ANOVA $119	Dynacomp, Inc. 1427 Monroe Ave Rochester, NY 14618	Regression, ANOVA	Basic Apple Atari TRS-80 PET
EdStat-Pac $20	Univ. of Mich., School of Education Ann Arbor, MI 48109	Descriptive, freqs., Chi-Square, ANOVA Two-Way ANOVA, nonparametric, regression correlation, Chronbach-Alpha	Basic Apple
Math-Stat $750	Mathematics Policy Research, Inc. P.O.Box 2393 Princeton, NJ 08540	Descriptive, cross-probability functions, correlation, ANOVA, regression, data management	IBM-PC CP/M
Micro-stat $325	Ecosoft PO Box 68602 Indianapolis Indiana 46268	Data Management transformation, descriptive, tests, ANOVA, plots, regression, time series, nonparametric, cross-tabs, distributions, chi-square	Basic CP/M IBM

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Package Name & Aprx.$	Vendor	Description	Language and System
Scientific Plotter $25	Interactive Microwave, Inc. PO Box 771 Dept. SK State College, PA 16801	Draws X/Y graphs, 20 symbols, error bars	MX Apple
Speed Stat 1 $200-$250	Soft Corp International 229 Huber Village Blvd. Westerville, OH 43081	Freqs., crosstabs, correlations, descriptives	Assem/ Basic Apple
Statistics Pac $100	Creative Discount Software 256 S. Robertson, Ste 2156 Beverly Hills, CA 90211	Data Management, curve fitting, probability, general statistics	Basic TRS-80 Apple
STATPRO $1995	Wadsworth Electronic Publ. Co. 20 Park Plaza Boston, MA 02116	Database management, Descriptive, corr., Regress., extensive multi-variate, graphics time series, ANOVA	Pascal Apple IBM
STATPAK $500	Northwest Analytical Inc. PO Box 14430 Portland, OR 97214	File management, probability, descriptive, regression, nonparametric, distributions, tests, chi-squared, ANOVA plots, random numbers	Basic CP/M IBM
INTRO-STAT 2.2 $150	Ideal Systems P.O.Box 681 Fairfield, IA 522550	Descriptive, crosstabs, totals, Mann-Whitney t, Wilcoxon, 1-2-way ANOVA, 2 variable scatterplot, Pearson correlations, simple linear regression, data file management	Apple
THE STATISTICS SERIES: Human Systems Dynamics 9249 Reseda Blvd., Suite 107 Northridge, CA 91324			
ANOVA II $150		ANOVA, ANCOVA, many designs, 1 to 5 factors, 2 to 12 levels. All interactions, marginals, means, cells, plots	MX Apple IBM
HSD REGRESS $100		25 vars., 300 cases, predicted, residuals, plots	MX Apple IBM
STATS PLUS $200		General Statistics package, database management, nonparametrics, freqs., corr., t-tests, regressions	MX Apple IBM

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GRAPHIC TOOLS

Pages and pages of reports. Who will read them? How can you spark the reader's interest? Some authors would argue that graphs and charts are the most effective way to communicate an idea. Most people hate tables of numbers and refuse to read more than a page or two of text. Rather, most people are visually oriented and can glean the basic message from a properly constructed graph.

Typically, we do not use graphics in our reports because we cannot afford a graphic artist and lack the necessary skills ourselves. However, the versatile microcomputer does have graphics capabilities.

Software

There are two basic types of software aids to graphing. Business graphics packages are designed to produce bar graphs, line graphs, and pie charts. The user enters the data values to be plotted and then selects the type of graph desired from a menu. The program automatically creates the graph on the screen and allows the user to change or dress it up before printing.

The second type, design or presentation graphics software, is more analogous to an artist's pallet and canvas. You draw lines, shapes, and colors on the screen and then edit them (shrink, expand, move). This type of graphics is not well suited for bar graphs, but its flexibility is perfect for diagrams, flowcharts, forms, and simple illustrations.

The choice of software will be greatly limited by the computers and printers each package supports. Other considerations include such features as options for inputting data, variety of graph types, and flexibility in editing the graph before printing.

Hardware

Will my Brand X microcomputer handle graphics? Perhaps. Obviously, the computer should be able to display graphics on the monitor screen, either in black and white, or color. While taken for granted with home computers designed for video games, this capability has been left out of most business microcomputers until recently. The resolution (or clarity) of graphics displays varies widely.

Actually, the real problem is getting the graph on paper. Until the last two years, most printers could handle only the simplest of graphics, and other printers were too expensive. Today there are a number of low-cost devices that can print graphics, though the visual quality still falls short of what a graphics artist could do.

The following examples illustrate three options for creating graphics.

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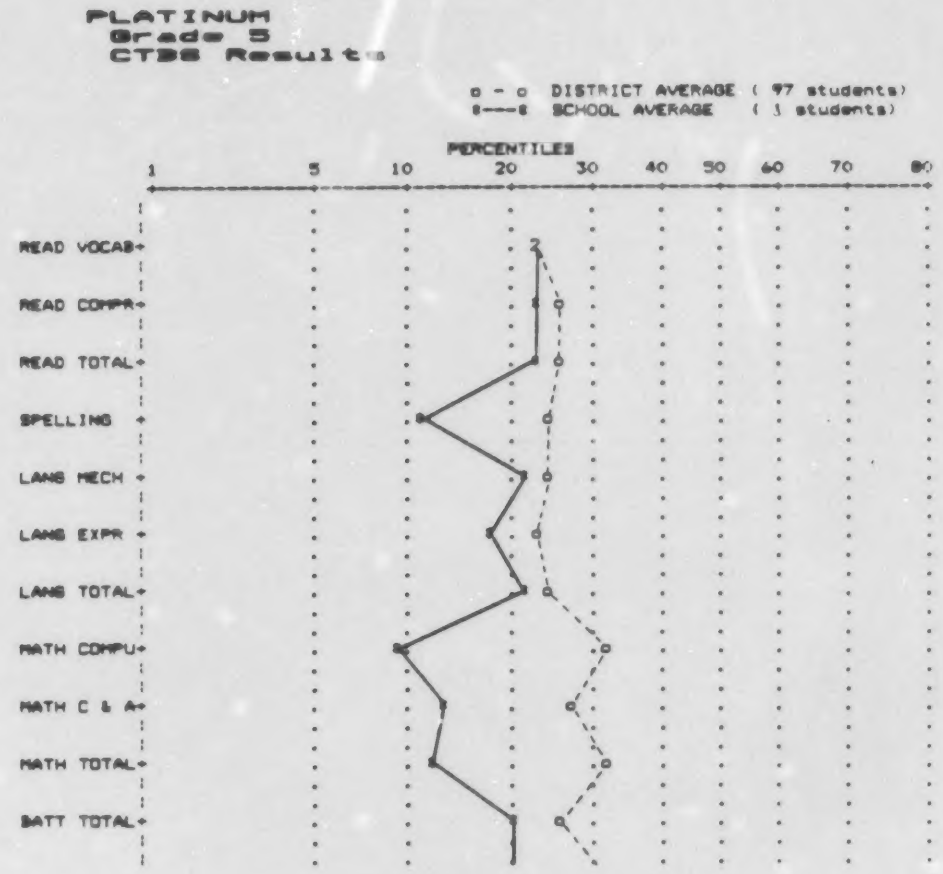
- Character graphics. Standard characters like *, /, and X are used to create a graph that can be output by any printer. The limited characters available usually result in poor visual quality. Figure 1 shows results that were plotted using character graphics. The connecting lines were drawn by hand.

Figure 1. School achievement profile using character graphics.



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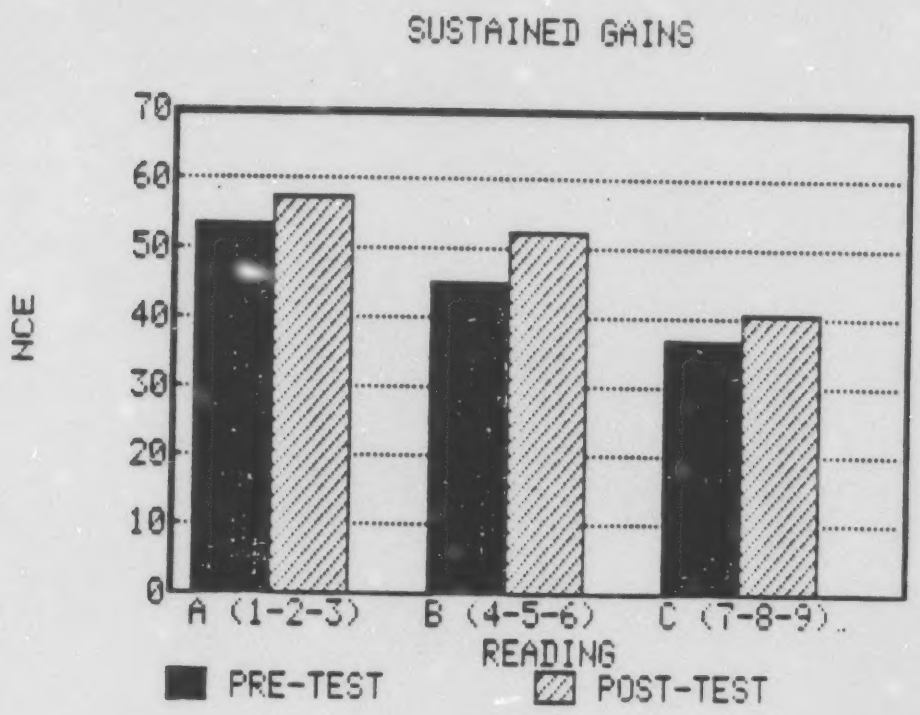
- Dot graphics. A dot matrix printer with a graphics option can produce graphs like Figure 2. The print head of a dot matrix printer consists of a row of pins which strike a carbon ribbon to form typewriter characters. With the proper software, the pins can be made to fire in any sequence to duplicate the shapes on the computer screen. The Prism by Integral Data Systems even has a multicolored ribbon to add color.

Figure 2. Bar graph of achievement gains using dot graphics.



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- Plotter graphics. A specialized device called a plotter can be use to generate good quality graphs like Figure 3. The graph is drawn by a colored pen held by a mechanical arm that functions much like the human arm. Examples of low-cost plotters include the Hewlett-Packard 7470A, the Houston Instruments Hiplot DMP-29, and the Strobe Graphics Plotter. At $800-2000, these plotters are still rather expensive since a printer will still be needed for standard text.

Figure 3. Example of plotter graphics quality.

Sampler of Business Graphics Software

Package	Computer	Comments
APPLEPLOT	Apple II	Easy to use but fewer features than some
PFS: GRAPH	Apple II	Works with PFS: FILE
VISIPLOT	Apple II	Best suited to time-oriented data
Lotus 1-2-3	IBM	Combines graphics capability with spreadsheet and file management
GRAFTALK	CP/M	Supports a variety of printers and plotters, and terminals

References

Bayle, E. Picture this--And do it yourself. Personal Computing, August 1982, 50-54; 58; 64; 150.

Bonner, P. Communicating with presentation graphics. Personal Computing, July 1983, 110-119.

Bowerman, R. Creative communication with computer graphics. Interface Age, October 1983, 68-69; 71-74; 160-168.

Mastering business graphics: Special report. Popular Computing, November 1983.

Reviews: Graphwrite for good graphics, 105-108; Business graphics for the IBM PC and Apple III, 124-126; Interface Age, October 1983.

COMMUNICATION TOOLS

Most people recognize that computers can communicate with other computers, but few people understand why this is important. Assume that you have test scores of a thousand students on a large computer and want to be able to analyze them on a small computer without re-entering the data; the computers must be able to exchange information even though the large computer may be miles away.

Currently the major applications of computer communications in evaluation are:

- Data communications - transferring data from large computers to small ones, transferring word processing documents between machines, transferring programs from one microcomputer to another.
- Remote data processing - use microcomputer as a terminal to control the analysis of data on large mainframe computers, using statistical software like SPSS.
- Online data base searching - access information utilities such as the Source, Dialog, and BRS to conduct bibliographic data bases maintained by those utilities. Two educational data bases are ERIC and RICE.
- Electronic message systems - Electronic mail systems, computer conferences, and electronic bulletin boards are examples of systems that allow other computers to call in and leave or receive messages.

There are several ways that communication may occur between computers, but we will focus on the most common form, telecommunications. Briefly, here is how it works. The computer is connected to a device called a modem which converts the electronic signal coming from the computer so that it may be sent over standard telephone lines. The modem at the other end translates the signal back to its original form and relays it to the computer. Thus, what you type at the keyboard is passed over the telephone line to the other computer and vice versa.

Software

The software tool used most frequently for telecommunications is known as a "terminal" program since the program essentially turns the microcomputer into a terminal (keyboard and display) hooked to a large computer. The main function of the program is to send characters typed at the keyboard out the cable to the modem and to interpret characters coming back from the modem.

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A Sampler of Terminal Programs

Program	Computer	Comments
ASCII Express	Apple II	Many fine features.
Crosstalk	CP/M, IBM	Available for a variety of computers; many features, such as protocol file transfers.
LYNC	CP/M	Unique license is for the institution, not just for a single computer. Available for a variety of computers.
Omniterm	TRS-80, IBM	
ST-80	TRS-80	Many features, such as error detection
VisiTerm	Apple II	

Hardware

The main piece of hardware required for communications is the modem, the device which sends signals over the telephone line and translates the incoming messages. The other piece of hardware needed is a serial port. The computer must have a way of transferring information out to the modem. This interface or port is usually known as an RS232 serial port. Most printers, in contrast, require a parallel port. Most business computers are sold with both ports, but others, such as the Apple II, need an additional circuit board.

A Sampler of Modems*

Company/Product (Price)	Computer	Comments
Hayes/ Smartmodem 300 ($289)	RS232C Interface	This auto-dialing, direct-connect modem is full duplex, with a variable baud rate of 110-300. Audio monitoring and self-testing are also features
MFJ/ MFJ-1232 ($129.95)	RS232C Interface; TTL/CMOS inputs/outputs	This acoustic coupler, full or half duplex modem has both 110 and 300 baud transmission rates. It may be connected to the Apple II game port, with MFJ-1231 software.
Novation/ D-CAI ($199)	RS232 Interface	This direct connect, auto-dialing modem is both full or half duplex with a 300 baud transmittion rate. It has a self-testing feature.

* From The, L. Data communications: A buyer's guide to modems and software. Personal Computing, March 1983, 102-103; 108-109.

Alternatives to Telecommunications

There are alternatives to the telephone for transferring information between computers. Local Area Networks link computers that are close in proximity so that they can share such information and peripherals as printers and hard disk drives. When the information transfer does not have to occur immediately, data can be moved using floppy disks as there are now programs which convert the format of a floppy disk from one computer to the format of another.

References

The, L. Data communications: A buyer's guide to modems and software. Personal Computing, March 1983, 96-103; 108-111; 114-117; 122-124; 127-128; 171; 173.

NETWORKING

A local area network is a coordinated system for communicating data. It is a system that lets computers, printers, disk drives, modems, and monitors interact with each other. A basic local area network (LAN) includes five components:

- the hardware, made up of computers and peripherals
- the network interface, typically an expansion card which plugs into the hardware
- the network master controller, either a chip on the expansion card, a hard disk drive, or a dedicated computer
- the network server, a hard disk drive that carries both the software for the LAN specifically and the programs available to network users
- the wiring to connect the parts of the network

The personal computer local networks most often used are made by Corvus systems, Inc. and Nestar Systems, Inc. Over 5,000 Corvus Constellation and Omninet networks, and nearly 1,000 Nestar Cluster/One and Plan--4,000 networks are currently in operation. These and some of the other more popular networks are described in the sampler of networks.

Two developments have helped to spread the use of local area networks. One is the change in the type of wiring which link together the components of a system. New cables (coaxial baseband wiring) have cut the cost of this important part of a network by two-thirds. They also transmit information far more quickly and may eventually be used to carry data, voice, and video messages simultaneously.

Another improvement is the way the network actually functions. The earliest systems used a star pattern, where the master controller (typically a hard disk drive) was located in the middle of "slave" terminals. The network distributed data from the center of the star along its arms to the terminal at each point. Communications were slow because everything had to be cleared and approved by the hard disk drive before it could proceed. But now a bus configuration is used where all of the hardware on the network issues instructions independently and the master controller simply directs the data traffic up and down the length of wiring.

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As was noted in the article, Networking the Workplace, from which the information for this section was drawn:

> 'The beauty of networking personal computers as compared with using minicomputers or mainframes is that with the mini or mainframe, each time you add a user to the system--each time you install a new dumb terminal--you detract from the overall computing power of the system. You simply slow the system down,' says Jim Pritchett, president of Trinity Computing Systems in Houston, Texas, which sells LANs to large installations. 'With the personal computer, though, it is just the converse. You add power to your system each time you enhance the network. You are giving it more memory or providing another peripheral or adding more storage capacity.' (Rothfeder, 1983)

Sampler of Networks*

Program/Company (Cost)	Computers	Description
OMNINET Interface card, $495; Network file server (with 18-Mb drive), $4,385 Corvus System, Inc. 2029 O'Toole Avenue San Jose, CA 95131 (408) 946-7700	Corvus concept Apple II, IBM - PC DEC LSI-11 TI Professional	Omninet links up to 64 workstations over a maximum distance of 4000 feet using twisted-pair wiring. The computer and peripheral interface cards contain a transporter or network master controller chip. The software server is attached to a hard disk drive. Disparate computers on the network communicate with each other.
PLAN 4000 Interface card, $595; Network file server (with 60-MB drive), $22,700 Nestar Systems, Inc. 2585 E. Bayshore Rd. Palo Alto, CA 94303 (415) 493-2223	Apple II, III IBM - PC	Plan 4000 links up to 64 workstations workstations over a distance of up to four miles using baseband coaxial cable. The computer and peripheral interface cards contain an intelligent chip--called Resource Interface Module (RIM)--to serve as the network master controller. The network file server is attached to a hard disk drive.

*Based on Rothfeder, J. Networking the work place. Personal Computing. June 1983, 7(6), 85.

Program/Company (Cost)	Computers	Description
ARCnet Interface card, $495; Network file server (with 10-MB drive), $10,000 Datapoint Corp. 9725 Datapoint Dr. San Antonio, TX 78284 (512) 699-700	Datapoint (TRS-80, Model 16 and Mode II by end of 1983)	ARCnet links up to 255 computers over a distance of up to four miles using baseband coaxial cables. The interface card contains the same intelligent chip--the RIM--as the one used in Nestar's PLAN 4000. The network file server is attached to a hard disk drive. Tandy Corporation has announced that it plans to have its Radio Shack Model 16 and Model II computers support ARCnet by the end of the year.
ETHERSHARE Interface card, $950; Network file server (with 10-MB drive), $11,500 3Com Corp. 1390 Shorebird Way Mountain View, CA 94043 (415) 961-9602	IBM - PC Apple (by late '83)	EtherShare and all other 3Com products operate on the Ethernet* network. An intelligent chip is connected to the interface card to manage the network. The file server, if a hard disk drive is not chosen, can also be a dedicated computer.
***ETHERNET** Xerox Corp. 6416 Wrenchwood Rd. Dallas, TX 75252 (214) 689-6045		Ethernet is an attempt to create a universal networking standard for computers. It is a coaxial baseband bus network that will hook up 1024 workstations over a distance of 2.5 kilometers. Its architecture and topology is not proprietary so separate distributors sell Ethernet-compatible products.
APPLENET Interface card, $500; Network file server, (to be announced) Apple Corp. 20525 Mariani Ave. Cupertino, CA 95014 (408) 996-1010	Apple Computers	Apple Net is just reaching market. It can accommodate workstations over a distance of 8000 feet in a bus configuration.

References

Neumann, R. Data banks: Opening the door to a world of information. Electronic Learning, November-December 1982, 56; 58-61; 83.

Rothfeder, J. Networking the work place. Personal Computing. June 1983, 7(6), 85.

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PLANNING FOR MICROCOMPUTER USE

People often find it is difficult to decide whether or not to buy a computer or what computer to buy without knowing what "capabilities" computers have. It should be clear from this workshop that a computer is a very sophisticated, generic tool that can be supplied with multiple capabilities including: word processing, data base management, calculation and statistical analysis, graphics, and communication. The only restriction is that the program having the instructions for these capabilities must be compatible with a given system in terms of the system's central processing unit, random access memory size, disk operating system and auxiliary storage features, and so on. Therefore, in making decisions about computers, one should start with an analysis of capabilities in relation to classes of software.

A three-step process can be used to guide one from the consideration of capabilities to the selection of a microcomputer system.

Step 1: Know Your Needs

The best place to begin is with an analysis of the tasks you do that could be accomplished using a particular microcomputer based program. These may be listed on a form such as that shown on the following pages, "Tasks/Software Matrix." Obviously, many tasks could be accomplished with the aid of a microcomputer; the question is, which ones should be transferred to a computer system? The following are some criteria to use in describing which tasks should be transferred:

1. Identify and eliminate tasks that are already being efficiently accomplished

2. Rate the remaining tasks in terms of
   a. potential for time/cost savings
   b. relative importance

Rating the tasks can be based on the general capabilities of software. For example, if much production typing is done, and any one document goes through many drafts, a word processing program would save the time and money associated with repeated typings.

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Step 2: Identify The Best Software

Once the top priority tasks are identified, the most appropriate software must be selected. This is where the evaluations presented in the various buyer's guides listed in each reference section of the workshop materials come in handy. These guides typically present extensive lists of programs with some identification of their features. The features are the ones described in the narrative sections of the workshop materials. For example, a buyer's guide to data base systems might include: number of records per file, number of fields per record, maximum field size, whether the files are fixed or variable, format of files, index scheme, special features, hardware requirements.

Evaluating software beyond the features listed in buyer's guides can be very confusing. The criteria listed in the following section, "Criteria for Review of Professional Software," are intended to facilitate reviewing professional software. They are grouped under the following topics: description of the package, documentation, inputs/operation, outputs, and general characteristics. The only way to assess software in regard to these criteria is to try it out.

Step 3: Identify Appropriate Hardware

As noted above, many software buyer's guides include hardware requirements. The form "Hardware Specifications Worksheet" on the following pages lists various hardware specifications. A separate sheet can be generated for each software package. Hardware selection can then be made based on the number of preferred packages that will run on a particular system. A formal way to make such a decision is shown in the "Hardware Evaluation Worksheet" shown at the end of this section. In making a final choice regarding a system, it is important to be aware of the families of microcomputers and the machines belonging to each family.

Compatibility among machines in a given family can broaden the range of possible choices. There are various types of compatibility. These include:

- complete software compatibility
- video compatible
- disk compatible
- operating system compatible
- compatible central processor chip

A demonstration of a particular software package on a particular system is the only sure way of proving compatibility.

Tasks/Software Matrix

Software Types / Tasks	**Word Processing** Enter, edit, and print text	**File Management** Create & maintain records; print reports	**Spreadsheets** Organize and manipulate numbers	**Test Generation** Create, edit & print instruments	**Data Collection** Gather data directly or via mark sense	**Statistical** Analyze and summarize data	**Graphics** Display results of data manipulation	**Telecom. & Networking** Communicate among computers

APPENDIX C

Microcomputer Presentation Materials

Two Sides of the Coin:

Microcomputers as Tools for Conducting Evaluation Research and as the Focus of Evaluation Research

Presented by

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JUNE 1984
NWREL

MICROCOMPUTERS AS TOOLS FOR CONDUCTING EVALUATION RESEARCH

POTENTIAL BENEFITS

- Appropriate microcomputer software for evaluation research tasks

POTENTIAL PROBLEMS

- People, organizational, and technological factors to consider

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EVALUATING THE USE OF MICROCOMPUTERS IN EDUCATIONAL SETTINGS

ASSESSING CURRENT CONDITIONS

- Instructional, administrative, and support services uses

DEFINING DESIRED USES

- Policy analysis as an evaluation research method

EVALUATING IMPACT

- Efficiency, equity, and quality issues

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TOOLS FOR CONDUCTING EVALUATION

RESEARCH TASKS

TASKS:	TOOLS:* Word Processing	Data Base Management	Calculation & Statistics	Graphics	Communication
Proposals & Planning					
Management					
Data Collection, Analysis, and Interpretation					
Reporting					

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*Stand alone or integrated packages

WORD PROCESSING

Text Entry Plus

- Formatting
- Editing
- Merging
- Printing

Advanced Features

- Hard disk compatability
- Macro-commands
- Preview printing
- Creates standard files
- Split screens or windows
- Print selected parts of file
- Mouse compatability

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DATA BASE MANAGEMENT

- FILE CREATION AND MAINTENANCE
- FILE STORAGE AND MANIPULATION
- RECORD RETRIEVAL
- PRINTING

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CALCULATION AND STATISTICS

SPREADSHEETS

- Calculate and recalculate
- Table look–up
- Logical decisions
- Printing

STATISTICAL ANALYSIS

- Descriptive stat
- Nonparametic stat
- Linear models
- Time series

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GRAPHICS

GRAPHICS TYPES

- Business/presentation
- Design

PRINTING TYPES

- Character
- Dot matrix
- Plotter (color, 3-D)

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COMMUNICATION

TELECOMMUNICATIONS

- Data communication
- Remote data processing
- On line data bank searching
- Electronic message systems

LOCAL AREA NETWORKS (LANs)

- Similar machines/programs
- Different machines/programs

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PEOPLE, ORGANIZATIONAL, AND TECHNOLOGICAL FACTORS.....

PEOPLE:

- Attitudes
- Knowledge
- Skills
- Interpersonal relationships

ORGANIZATIONAL:

- Goals
- Structure
- Funding
- Planning and development
- Implementation and evaluation

TECHNOLOGICAL:

- Software/hardware:
  Selection, Maintenance, Service, Support
- Facilities:
  Space, Funiture, Lighting,
  Power, Security

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ASSESSING CURRENT CONDITIONS

USES	FACTORS		
	Technological	Organizational	People
Instructional CAI Problem Solving Computer Literacy/science			
Administration and Support Services Local District-wide			

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DEFINING DESIRED USES

- POLICY ANALYSIS CAN HELP WITH:

  - Clarification
  - Question development
  - Data collection, analysis and interpretation
  - Adoption of alternatives and their implications

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EVALUATING IMPACT

- EFFICIENCY
- EQUITY
- QUALITY

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APPENDIX D

Cost Analysis Workshop Materials

Presenter's Guide
Cost Analysis Workshop

The workshop follows the outline order exactly. First look at the outline and read the "Cost Analysis Workshop" article. These two resources describe the workshop.

Next look at the transparency set. They follow the order of the outline. Important points and transitions are noted in italicized comments.*

The "Cost Analysis Workshop" article lists the materials to be handed out to participants. All materials are included in this set of materials. See also the background materials file for additional materials.

---

*Following the transparency used for the workshop is the same transparency shown with notes and comments.

COST ANALYSIS WORKSHOP

Introduction
- What is cost analysis?
- Why do a cost study?

Terminology
- Cost analysis versus cost effectiveness analysis ...
- Descriptive versus comparative cost analysis studies

What is Cost Analysis?
- Cost feasibility
- Cost utility
- Cost benefit
- Cost effectiveness

How to select a method
- Consider the decision problem; are there alternatives?
- Is the relationship of cost to outcome important to the decision maker?
- What outcome data are attainable?
- Are effectiveness measures most relevant to the decision maker?

How to conduct a cost analysis
- Identify ingredients
  - What ingredients should be included?
  - When should different ingredients be included?
  - What is learned by listing ingredients?
    - identifies components of the program
    - points to reliability of the funding sources
  - Why budgets are not used as lists of ingredients
- Cost out the ingredients
  - pricing
    - market
    - shadow
  - adjustments
    - if ingredients are shared (joint)
    - if ingredients last longer than 1 year (annualized values)
    - if program lasts more than 1 year (present values)
  - distribution of costs

Putting costs and outcomes together
- Transportation study example (see handout)
- Computer training example in "Cost analysis for educational administrators" paper

Factors to consider when deciding whether to do a cost study
- Pragmatic
  - are alternatives being considered
  - time
  - cost
  - availability of cost data
  - availability of outcome data
  - expertise of the staff
  - availability of expert resource
- Political
  - Is the decision maker interested in the results?
  - What factors besides cost and outcome might influence the decision makers?
  - What are the advantages and disadvantages of cost analysis information?

Exercises and discussion (20 minutes)

Summary
- Streamlining
  - Ingredients
    - list only additional ingredients if program is an adjunct to an existing program
    - list only the largest ingredients
    - use ingredients list of a similar program
    - set up budget so that future studies can use the budget to list ingredients
  - Costing out
    - use market prices as estimates
    - look at one year of program only so to avoid having to adjust the prices
    - do not cost out "free" ingredients such as volunteers
    - use cost estimates figured by a similar program
  - Outcomes
    - ignore effects (feasibility)
    - estimate effects (utility)
    - use already collected data (last years)
    - use another program's data

Wrap-up
- Review the 4 methods
- Discuss questions that could be answered in own district using these methods

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Cost Analysis Workshop

A workshop on cost analysis for school administrators has been developed which provides an introduction to four cost analysis methods. This workshop teaches skills needed for selecting the most appropriate cost analysis method to use in the evaluation of an educational program. Developed by Jana Kay Smith, this cost analysis workshop has been conducted in educational agencies in Arizona, California, and Colorado.

Each workshop participant receives a packet of materials which includes an outline of the workshop, a glossary of cost analysis terms, definitions of the four cost analysis methods, a set of exercises, and a recently published paper by Jana Kay Smith and Nick L. Smith (1984) entitled "Conversational Cost Analysis for Educational Administrators." This paper describes the four methods in detail and provides a listing of useful references.

From Research on Evaluation Newsletter Vol 6, Issue 4, April 1984, p. 2-4
Research on Evaluation Program
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Portland Oregon 97204

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The three-hour workshop begins with a discussion of the rationale for conducting cost analysis studies. It is pointed out that traditional economists have looked only at costs, while traditional educational researchers have looked only at program outcomes. At the present time, given funding cuts and the resulting increase in questions about the relationship of program costs to program outcomes, decision-focused evaluators have begun to look at both program costs and program outcomes.

The participants are then introduced to potential applications of cost analysis methods, beginning with a discussion of eight common questions that can be answered by these methods. These are questions often asked by administrators, program coordinators, program participants, and even members of the community. For example, community members may ask, "What are we getting for our tax money?" Workshop participants are encouraged to generate additional cost-related questions that they have encountered in their own evaluation experience.

Once the purpose of cost analysis methods in educational evaluation is made clear, four methods, cost feasibility, cost utility, cost benefit, and cost effectiveness are defined in every day terms. For example, the participants are encouraged to imagine themselves on a car lot looking at new pickup trucks. They are given the scenario that they have saved $6000 to buy a new truck (and don't want to use credit). They see Truck A for $5500 and Truck B for $7500. Which purchase is feasible within their financial constraints and which is not? Obviously, it is feasible to purchase Truck A. This is an example of cost feasibility reasoning.

Suppose, however, the participants wanted to go beyond feasibility and try to get the most for their money? If they were in farming and wanted the truck to haul hay, they might look at the power of the trucks. In this case, Truck A will haul up to 3 tons of hay, while Truck B will haul up to 9 tons of hay. By comparing the cost of the trucks to their hauling effectiveness, you can see that it will cost $1,833 ($5500/3) to haul a ton of hay with Truck A, compared to only $833 (7500/9) to haul a ton of hay with Truck B. Clearly, Truck B is the most cost effective selection.

Once the difference between the four cost analysis methods is understood, examples of their applications for educational evaluation are described. A flow chart is used to delineate the steps of method selection.

The workshop then becomes more specific and looks in detail at the step common to all cost analysis methods: assessing the costs of a program. For assessing the costs of a program, the ingredients approach proposed by Henry Levin (1983) is recommended. Participants are given the opportunity to generate a comprehensive list of all ingredients (factors) necessary to run a hypothetical second grade reading program. This list must include all ingredients of a program, incuding "free" ingredients such as volunteers and equipment. The cost of equipment used must be calculated even if it is just borrowed from another program for a few hours a week (e.g., a computer).

Following generation of this list of ingredients, an explanation is given as to why the use of a budget for estimating the cost of a program is insufficient. For example, a budget does not include free resources, may not include ingredients that have already been paid for (such as the building), and may omit ingredients that are shared across programs. The budget, because it omits these ingredients, may result in a distorted picture of what it takes to run a program. Such a budget could not be used by administrators of another school to estimate what it would take for them to adopt the program.

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Once the concept of ingredients is clear, techniques of determining the costs of such ingredients are touched upon. Here we look at use of market and shadow prices, and price adjustments that may be needed if the program lasts several years or if the ingredient has a longer life than the program itself. Because these adjustments are quite technical, participants are introduced to the concepts in a general, rather than a detailed, manner.

Following that, actual applications of the four cost analysis methods in educational evaluation are discussed. Also at this time, additional factors which may affect the conduct of a cost analysis are discussed. From the Research on Evaluation Program's ongoing series of studies on impediments to the conduct of cost analysis in education, a set of pragmatic factors, such as the availability of data, and the time and the cost of conducting studies, have been identified which affect the conduct of a cost analysis study. In addition, political factors, such as the decision maker's support for the study, have been shown to influence the conduct of the study and the use of study results.

Consideration of these factors is important when deciding whether to conduct a study and when selecting the most appropriate method for the analysis. Following this discussion, participants are given a set of exercises which contain a practical mix of pragmatic and political constraints and are asked to select the most appropriate cost analysis method for the evaluation.

The workshop concludes with a discussion of methods of "streamlining" the steps of (1) listing ingredients, (2) valuing ingredients, and (3) measuring outcomes. For each step, a minimum of four streamlining techniques are offered. For example, in some cases, only the largest ingredients might be listed, or already collected measures of outcomes may be used. The effect of each streamlining technique on the reliability and validity on the study is emphasized and participants are encouraged to consider adopting any of the streamlining techniques only with caution.

Development of the workshop was funded by the Region 4 Chapter 1 Technical Assistance Center and the Research on Evaluation Program. For more information about the cost analysis workshop, contact Dr. Jana Kay Smith, NWREL, 300 S.W. Sixth Avenue, Portland, OR 92704.

References

Levin, H. M. (1983). Cost-Effectiveness: A Primer. Beverly Hills, CA: Sage Publications.

Smith, J. K. & Smith, M. L. (1984). Conversational cost analysis. Management Information, School Information and Research Service, Olympia, WA, 3(5), 21-27.

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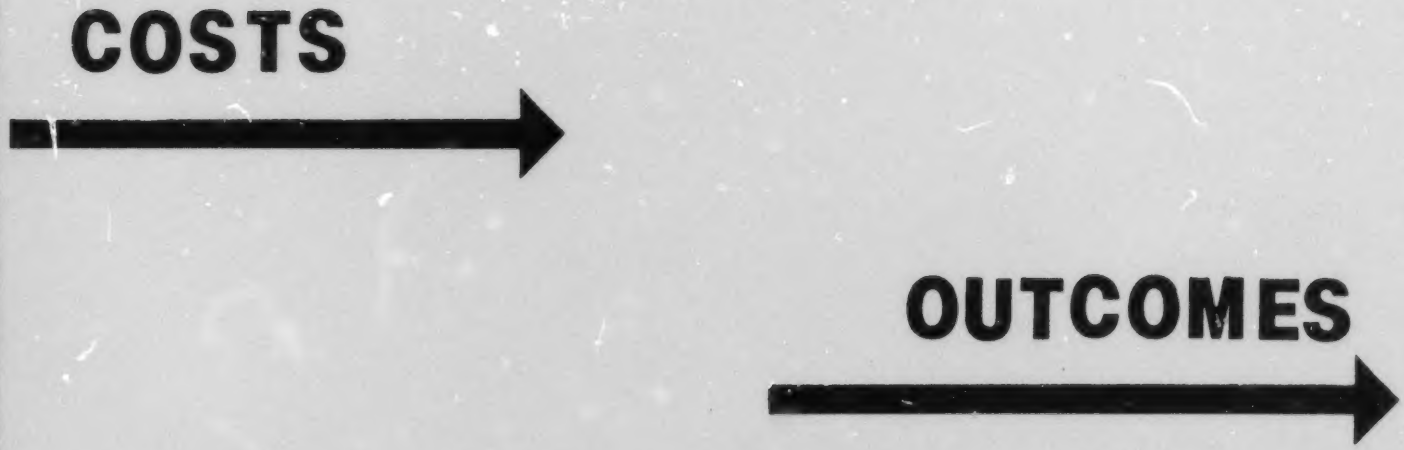

COSTS
OUTCOMES

PROGRAM

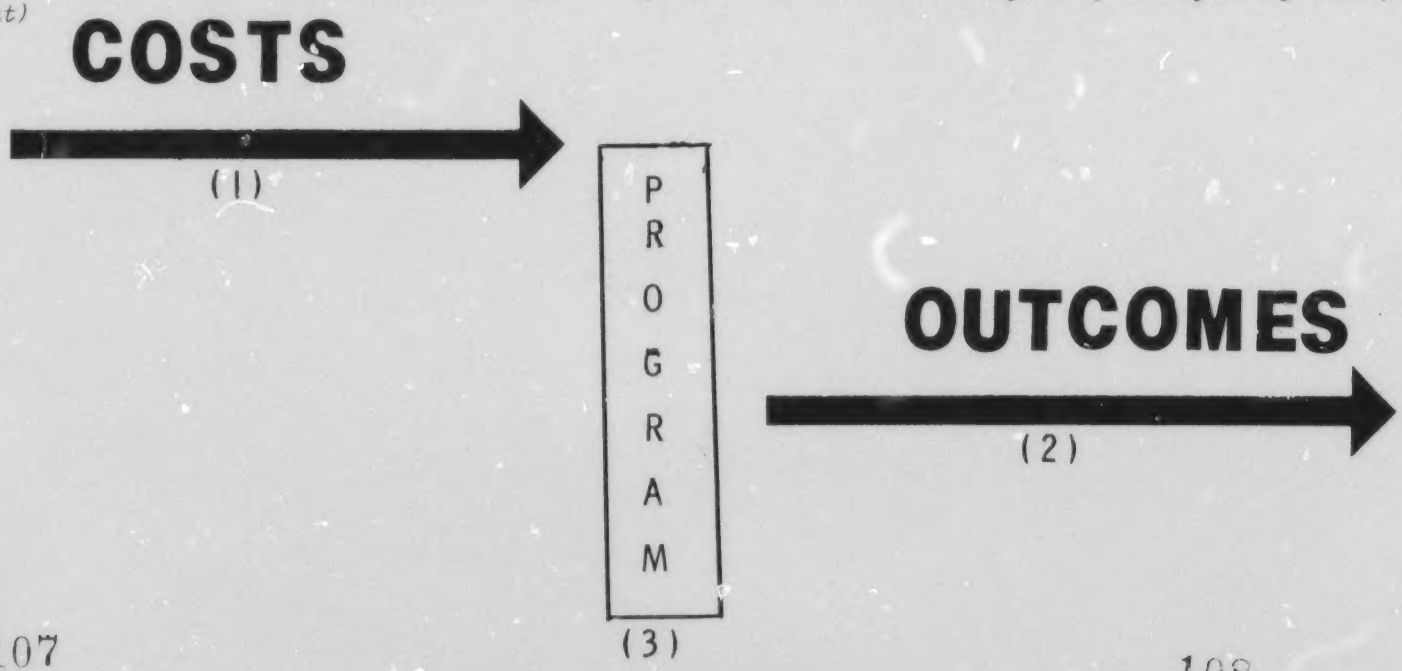
This is a 3-tiered transparency. Points 1,2,3 refer to layers of the transparency set.

Why do we look at costs and outcomes in evaluation?

1. *In the past traditional economists looked only at costs. However, in doing this the decision maker may select the least expensive option without knowing if it works! You can not assume that an expensive program works while an inexpensive one doesn't work!*

2. *In contrast, educational researchers have focused on outcomes. The problem here is that a program that is only slightly more effective may be much more expensive. You wouldn't know without looking at costs also.*

3. *The Decision Focused View looks at what it costs to produce outcomes. This view has evolved due to reduced funding to education. The methods were developed in Sputnik era. (all three layers of transparency down for this point)*



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• COST ANALYSIS WORKSHOP OBJECTIVES •

To increase understanding of:

- Four cost analysis methods
- Method selection
- Cost ingredients
- Cost-outcome ratios
- Factors affecting cost analysis methods
- Techniques of "streamlining"

To practice identifying appropriate application

• COST ANALYSIS WORKSHOP OBJECTIVES •

Set parameters of the workshop and limits of the appropriateness of the Methods here. Point out:

**The analysis is limited in terms of the information it can provide - but it can be useful in certain situations. We'll talk about those situations... contest of use.*

**We'll look at comparisons across 2 or more programs-hence it is a way to do a program evaluation usually within a school or district. (not nationwide or policy) Programmatic level*

**Analysis consists of discrete steps--each step alone can provide useful information. You don't need to do the whole thing to get good information*

To increase understanding of:

- Four cost analysis methods
- Method selection - *given a situation or problem, which analysis is most appropriate?*
- Cost ingredients
- Cost-outcome ratios
- Factors affecting cost analysis methods - *Political and practical*
- Techniques of "streamlining" *or ways to make the analysis more feasible or "do-able" in educational evaluation*

To practice identifying appropriate application *using set of exercises involving educational evaluation*

Have them look at packet materials now

QUESTIONS ASKED BY:

- MANAGER (OR CONSUMER)
- ADMINISTRATOR
- PARTICIPANT
- COMMUNITY

Why did the decision focused view evolve:

To answer

QUESTIONS ASKED BY:

- MANAGER (OR CONSUMER) - *someone considering adopting the program*
- ADMINISTRATOR - *Where is the most money being spent?*
- PARTICIPANT - *What am I getting for my money?*
- COMMUNITY - *Where do our tax monies go?*

You can either show the next slide and identify the askers of the questions -
Or have participants generate a list of questions about costs and/or outcomes

TO ANSWER QUESTIONS

- What resources are needed to run the program?
- What makes the program so expensive?
- Can we afford the program?
- Can we afford the program in 1987?
- Will we have funding in 1987?
- What are start up versus maintenance costs?
- Which program gives us the most outcome for the least money?
- How can costs be minimized?

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Such As...

~~TO ANSWER QUESTIONS~~

- What resources are needed to run the program? - *Manager/admin.*
- What makes the program so expensive? - *admin./community*
- Can we afford the program? - *(can we afford to start it? Can we afford to maintain it?)*
- Can we afford the program in 1987? - *given inflation etc.*
- Will we have funding in 1987? - *How reliable are the funding sources*
- What are start up versus maintenance costs?
- Which program gives us the most outcome for the least money?
- How can costs be minimized?

Cost Analysis steps can answer these questions. The resultant information can be used in decision making.

• COST ANALYSIS •

- COST FEASIBILITY
- COST UTILITY
- COST BENEFIT
- COST EFFECTIVENESS

Definition time. People will get terms mixed up. We use Cost Analysis (CA) to describe the 4 methods below. Levin used cost effectiveness (CE) to describe the 4 methods. The problem here is that people start asking about the CE of a cost utility analysis! Be careful to not mix the terms up as you describe them.

• COST ANALYSIS •

- COST FEASIBILITY - *Descriptive of 1 program or comparative to select between 2 or more programs*
- COST UTILITY
- COST BENEFIT - *Comparative - to select between 2 or more programs*
- COST EFFECTIVENESS

COST-ANALYSIS METHODS

INPUT	OUTCOME	METHOD
Costs	-------	Feasibility
Costs	Estimates	Utility
Costs	Direct measures	Effectiveness
Costs	Monetary measures	Benefit

Refer to hand-out that defines the 4 methods.
Cover columns 2 and 3 and point out that the common denominator of all methods is assessing costs! The difference between the methods is the way they look at outcomes. Say "We all do cost analyses every day," and describe each method in practical terms.
*For example, consider buying a car**

COST-ANALYSIS METHODS

INPUT	OUTCOME	METHOD
Costs	-------	**Feasibility** - *Can I afford it?*
Costs	Estimates	**Utility** - *Do I need it? Is it useful?*
Costs	Direct measures	**Effectiveness** - *Which model runs better for least money?*
Costs	Monetary measures	**Benefit** - *Which model has better resale value? Can theoretically compare different types of outcomes. There are some definition problems that may be brought up by participants - say that, for now, CB is best for comparing outcomes of same or similar types of programs- e.g. not $ value of health ed. versus $ value of typing training. Rather compare typing with computers (e.g. similar skills)*

* *Of course, in buying a car these types of information won't determine exactly which car you'll buy! Other factors always affect a decision such as family needs, personal preferences for sportiness etc. CA is not a determinant - just another bit of information for decision making.*

PRICING METHODS	ADJUSTMENTS FOR PRICING
MARKET PRICING	JOINT COST
SHADOW PRICING	ANNUALIZED COST
	PRESENT COST

I don't use this since it is too complex. You should, however, be aware of these concepts.

PRICING METHODS	ADJUSTMENTS FOR PRICING
MARKET PRICING	JOINT COST - *if shared ingredients e.g. Ms. Jones 1/2 time*
SHADOW PRICING	ANNUALIZED COST - *if computer or building lasts more than 1 year - figures value based on depreciation and interest*
	PRESENT COST - *if program lasts more than one year*

Uses annualization table in Levin's book

Mention CF first since there are no outcomes. Next move to CU & CE - both use outcome measures very familiar to evaluators Could have participant generate this list.

** First we'll look at conceptual models then go back and describe them step-by-step.*

UTILITY AND EFFECTIVENESS

- LEARNING *e.g. NCE gains test scores*
- SATISFACTION- *parents, community, participants*
- PHYSICAL SKILLS- *tying shoes, etc.*
- PROGRAM COMPLETIONS
- REDUCTIONS IN DROPOUTS
- EMPLOYMENT OF GRADUATES
- COLLEGE PLACEMENT OF GRADUATES

UTILITY AND EFFECTIVENESS

- LEARNING
- SATISFACTION
- PHYSICAL SKILLS
- PROGRAM COMPLETIONS
- REDUCTIONS IN DROPOUTS
- EMPLOYMENT OF GRADUATES
- COLLEGE PLACEMENT OF GRADUATES

BENEFIT

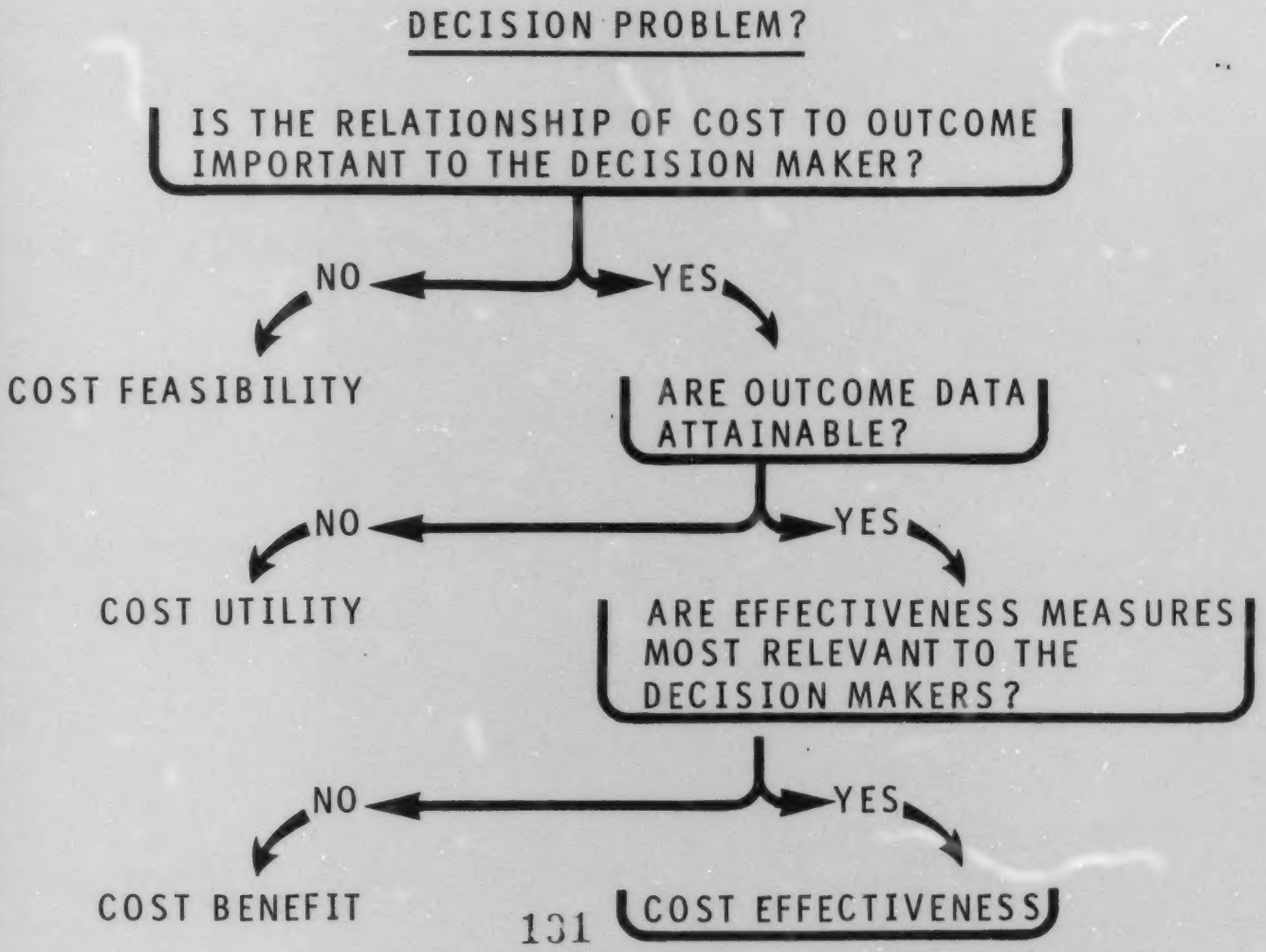
- DOLLAR VALUE OF LITERACY
- INCREASE IN INCOME
- DOLLAR VALUE OF IMPROVED QUALITY OF LIFE
- DOLLAR VALUE OF INCREASING LIFE SPAN BY 2 YEARS
- COST SAVINGS TO PARTICIPANTS

Mention again, benefit allows comparison of very different types of outcomes such as math and reading. Note that such comparisons rarely occur in educ. evaluation. Rather, it is a comparison of reading CAI versus reading Tutor. For this workshop we will attend primarily to benefit of programs with same or similar outcomes.

BENEFIT

- DOLLAR VALUE OF LITERACY
- INCREASE IN INCOME - *e.g. vocational education*
- DOLLAR VALUE OF IMPROVED QUALITY OF LIFE - *stress reduction, "willingness to pay"*
- DOLLAR VALUE OF INCREASING LIFE SPAN BY 2 YEARS - *if stop smoking heart patient rehabilitation*
- COST SAVINGS TO PARTICIPANTS - *if taught to do something they'd have to pay someone else to do, e.g. mechanics, self care.*

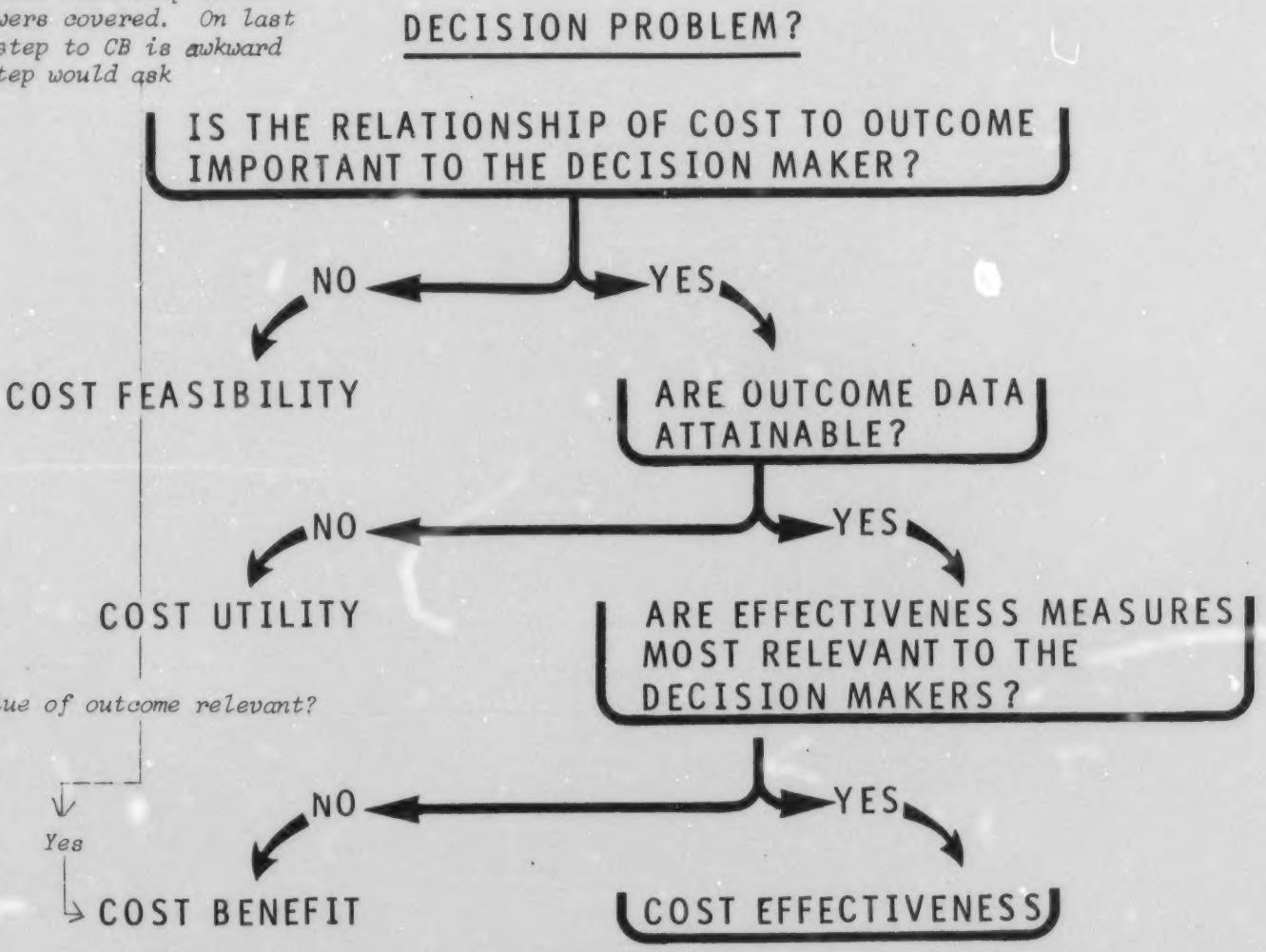
METHOD SELECTION



To review the methods just described have participants work through this decision tree.

METHOD SELECTION

I make them answer each step while I keep the answers covered. On last step the "No" step to CB is awkward and another step would ask



Is a dollar value of outcome relevant?

Yes

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INGREDIENTS

- ALL RESOURCES LISTED (INCLUDING VOLUNTEERS)
- FINE DETAIL NEEDED (E.G. PERSONNEL VERSUS TEACHER A, TEACHER B, ETC.)
- CATEGORIZE BY ORDER OF COST MAGNITUDE (E.G. PERSONNEL FIRST)

Now to Costs -
First step is to list "Ingredients" or "Factors" needed to run the program. Cost is irrelevant here - all you want is a listing of items necessary for the program.

INGREDIENTS

- ALL RESOURCES LISTED (INCLUDING VOLUNTEERS)
  and 'free' resources
- FINE DETAIL NEEDED (E.G. *not* PERSONNEL VERSUS *but rather* TEACHER A, TEACHER B, ETC.)
- CATEGORIZE BY ORDER OF COST MAGNITUDE (E.G. PERSONNEL FIRST)

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INGREDIENTS	BUDGET
Includes "free" resources	Includes only financial resources
Includes "sunk" resources	May not include "sunk" resources
All materials even if shared by another program (e.g. computer)	Shared materials may be included in only one program's budget
Costs figured for total program span	Costs figured for fiscal year only
Based on spent resources	Based on allocated resources

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Inevitably people say - Well, why can't we just use our budget?

INGREDIENTS	BUDGET
Includes "free" resources	Includes only financial resources
Includes "sunk" resources *e.g. room rental if building already paid*	May not include "sunk" resources
All materials even if shared by another program (e.g. computer)	Shared materials may be included in only one program's budget
Costs figured for total program span - *to avoid one time capital outlay distortion (e.g. bus cost)*	Costs figured for fiscal year only
Based on spent resources	Based on allocated resources

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"Hidden" costs →

Shows - maybe, what your school pays-but wouldn't tell others what they would need to implement the program!

THE INGREDIENTS APPROACH TO MEASURING COSTS

CATEGORY	COST	TOTAL
_____		
_____	_____	
_____	_____	
_____	_____	_____
_____		
_____	_____	
_____	_____	
_____	_____	_____
_____		
_____	_____	
_____	_____	
_____	_____	_____
_____		
_____	_____	
_____	_____	
_____	_____	_____

Have them list ingredients. You might provide a descriptions of a program and have them generate ingredients such as:

THE INGREDIENTS APPROACH TO MEASURING COSTS

Note: Note how useful it is to just list the ingredients to show what it takes to run the program!

Cover

CATEGORY	COST	TOTAL
Personnel		
Mrs. Jones 1/2 time		
Mr. Smith full time		
Susie - tutor		
Rental		
room rental		
Equipment		
Apple IIe		
paper		
manuals		
Misc. evaluation		
staff training		

You could use the Chapter 1 example here too.

★ DISTRIBUTION OF COSTS ★

COSTS TO:

- SPONSOR
- OTHER AGENCIES
- VOLUNTEERS (CONTRIBUTED INPUTS)
- PARTICIPANTS (IMPOSED INPUTS)

Besides identifying costs, the reliability of funding can be determined. This lets you better answer the question - will we have funding in 1987?

★ DISTRIBUTION OF COSTS ★

You may find a distribution for program to be 2/3 district funded, 1/6 State and 1/6 federally funded.

COSTS TO:

- SPONSOR
- OTHER AGENCIES
- VOLUNTEERS (CONTRIBUTED INPUTS) - *donated equipment and personnel time*
- PARTICIPANTS (IMPOSED INPUTS)

COMPUTER SKILLS TRAINING
COURSES

PROGRAM	# STUDENTS	LANGUAGE	WHERE
A	20	BASIC HANDS-ON	CC
B	20	WORKBOOK	HS

Now to an example. SIRS paper (Cost Analysis for Educational Administrators) p. 21*

This example compares 2

COMPUTER SKILLS TRAINING COURSES

PROGRAM	# STUDENTS	LANGUAGE	WHERE
A	20	BASIC HANDS-ON	CC
B	20	WORKBOOK	HS

Look at p. 22 where program costs are figured. Point out that only costs in addition to regular classroom costs are calculated.

The listing of the costs is the cost feasibility analysis.

**Smith & Smith (1984).*

TABLE 2

COST-UTILITY ANALYSIS

	PROGRAM A	PROGRAM B
PROBABILITY	.6	.2
UTILITY	6	6
EXPECTED UTILITY	(.6) (6)=3.6	(.2)6=1.2
COST PER PUPIL	$500	$300
COST-UTILITY RATIO	$500/3.6=$138.80	$300/1.2=$250.00

P. 23[4] This example only looks at one outcome so utility doesn't really need to be included. If you also had, say, a "comfort" index for computer use you'd add the written-in figures.

TABLE 2

COST-UTILITY ANALYSIS

		PROGRAM A	PROGRAM B
a.	**PROBABILITY** *(increasing test scores)*	.6	.2
b.	*Probability (increasing comfort)*	.6	.4
a.	**UTILITY** *(increasing test scores)*	6	6
b.	*Utility (increasing comfort)*	5	5
a.	**EXPECTED UTILITY** *(test)*	(.6) (6)=3.6	(.2)6=1.2
b.	*Expected Utility (comfort)*	(.6) (5) = 3.0	(.4)(5)= 2.0
	COST PER PUPIL	$500	$300
	COST-UTILITY RATIO	$500/3.6=$138.80	$300/1.2=$250.00
		500/ 3.0 + 3.6 500/6.6 = 75.75	300/1.2 + 2.0 300/3.2 = 93.75

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[4]Of Smith and Smith, 1984.

150

150A

TABLE 3

COST-BENEFIT ANALYSIS

	AVERAGE COST	AVERAGE BENEFIT	COST/BENEFIT	NET BENEFIT
PROGRAM A	$500	$400	500/400=1.25	-$100
PROGRAM B	$300	$600	300/600= .50	+$300

TABLE 3

COST-BENEFIT ANALYSIS

	AVERAGE COST	AVERAGE BENEFIT (*Increase income per year*)	COST/BENEFIT	NET BENEFIT
PROGRAM A	$500	*Restricted job market since less language* → $400	500/400=1.25 *It cost $1.25 to raise income $1.00*	400-500 = -$100
PROGRAM B	$300	*Perhaps more jobs since more language?* → $600	300/600= .50 *It cost 50¢ to raise income by $1.00*	600-300= +$300

*Of Smith and Smith, 1984.

TABLE 4
COST-EFFECTIVENESS ANALYSIS

	COST PER PUPIL	EFFECTIVENESS	COST-EFFECTIVENESS
PROGRAM A	$500	20 POINTS	$500/20-$25
PROGRAM B	$300	5 POINTS	$300/5 -$60

TABLE 4
COST-EFFECTIVENESS ANALYSIS

	COST PER PUPIL	EFFECTIVENESS	COST-EFFECTIVENESS
PROGRAM A	$500	20 POINTS	$500/20-$25
PROGRAM B	$300	5 POINTS	$300/5 -$60

If Ch 1 audience might mention error band around NCE's or how to interpret if gain is in percentiles

COMPARISON

Cost	Select
Feasibility	B
Utility	A
Benefit	B
Effectiveness	A

COMPARISON OF EXAMPLE ANALYSES OUTCOMES

COST		SELECT
FEASIBILITY	*just costs*	B
UTILITY	*effectiveness = hands on*	A
BENEFIT	*income = workbook*	B
EFFECTIVENESS	*effectiveness = hands on*	A

This points to the importance of identifying relevant program outcomes prior to conduct of the study. You would not ordinarily do all 4 analyses. This is for example only.

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PRAGMATIC

- EXISTENCE OF ALTERNATIVES
- TIME
- COST
- AVAILABILITY OF COST DATA
- AVAILABILITY OF OUTCOME DATA
- EXPERTISE OF THE STAFF
- AVAILABILITY OF EXPERT ADVICE

Consider these carefully before undertaking a CA study.

PRAGMATIC

- EXISTENCE OF ALTERNATIVES - *Do 2 or more programs need to be compared? if not - what's the decision?*
- TIME - *It may or may not take more time than an outcome evaluation depending upon availability of cost data*
- COST
- AVAILABILITY OF COST DATA - *if not, just do outcome evaluation*
- AVAILABILITY OF OUTCOME DATA
  Consider CF or CU
- EXPERTISE OF THE STAFF
- AVAILABILITY OF EXPERT ADVICE

POLITICAL

- IS THE DECISION MAKER INTERESTED?
- WHAT OTHER FACTORS MIGHT INFLUENCE THE DECISION MAKER?
- WHAT ARE THE ADVANTAGES AND DISADVANTAGES?

POLITICAL

- IS THE DECISION MAKER INTERESTED?

Will the information be used? If not, why bother?

- WHAT OTHER FACTORS MIGHT INFLUENCE THE DECISION MAKER? - *If decision makers can't agree on outcome measures - no analysis will fit.*

Is funding available to support at least 1 program?

- WHAT ARE THE ADVANTAGES AND DISADVANTAGES? *of having this information?*

What if the most politically preferred program is least cost effective? etc.

* *Exercises should be completed by participants now.*

OUTCOMES

- IGNORE EFFECTS *(feasibility)*
- ESTIMATE EFFECTS *(utility)*
- USE ALREADY COLLECTED DATA *(last years)*
- USE ANOTHER PROGRAM'S DATA

STREAMLINING

OUTCOMES

- IGNORE EFFECTS *(feasibility)*
- ESTIMATE EFFECTS *(utility)*
- USE ALREADY COLLECTED DATA *(last years)*
- USE ANOTHER PROGRAM'S DATA

STREAMLINING

Conclude with discussion of uses in the audiences schools/districts

COSTING OUT

- LOOK AT COST OF PROGRAM FOR ONE YEAR ONLY
- DO NOT COST OUT "FREE" INGREDIENTS
- USE COST ESTIMATES FIGURED BY A SIMILAR PROGRAM

These techniques are reasonable - they do, however, compromise the results. Hence, their influence on analysis results should be recognized...These streamlined techniques should be used for local evaluations only(not to be published etc. since they estimate cost for the specific school/district only)

COSTING OUT

- LOOK AT COST OF PROGRAM FOR ONE YEAR ONLY - *Then annualized & present value adjustments are not necessary.*
- DO NOT COST OUT "FREE" INGREDIENTS
  - *Only cost out ingredients that go beyond regular program costs. (additional ingredients only)*
- USE COST ESTIMATES FIGURED BY A SIMILAR PROGRAM - *if in your district etc.*

STREAMLINING

Note: Listing ingredients is simple, so no streamlining is recommended for that step.

COST ANALYSIS METHODS

cost feasibility — estimates the costs of a program or programs with resources available to see if they are affordable

- \+ useful for program planning
- \- does not measure effectiveness

cost utility — compares costs and outcomes for two or more programs, where outcomes are estimated

- \+ many types of outcomes can be included
- \+ imperfect information and uncertainty can be addressed systematically
- \- results are not replicable

cost benefit — compares the costs and outcomes for two or more programs, where outcomes are measured in dollars

- \+ many types of outcomes can be included
- \+ analysis is replicable
- \- it is difficult to value educational outcomes monetarily

cost effectiveness — compares the costs and outcomes for two or more programs, where outcomes are measured in test scores, behavioral ratings, etc.

- \+ effects data may be available
- \+ analysis replicable
- \- can only compare programs with similar outcomes

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From: Management Information, School Information and Research Service, 3(5), Olympia, WA, 1984

Conversational cost analysis for educational administrators

By Jana K. Smith and Nick L. Smith

There is no need to begin this paper with a description of the stress placed on educational systems by budget reductions. Nor is it necessary to point out increased demands for accountability. These are now familiar issues faced daily by educational administrators. What is not as familiar to most of us, however, are the seemingly esoteric cost analysis techniques that are being touted as the best methods for managing remaining available funds and for providing accountability data.

Cost analysis is not really as unfriendly or forbidding as many educators imagine

Cost analysis sounds mechanical and unfeeling, and some people would probably prefer to keep such methods out of education. Educational benefits cannot be translated into dollars! Other people are put off by the apparent complexity of cost analysis techniques. However, cost analysis is not really as unfriendly or as forbidding as many educators imagine.

In the next few pages, we will introduce you to four common cost-analysis methods and provide examples to illustrate that these techniques, as applied to the evaluation of instructional programs, are much more straightforward and understandable than you might have thought. We are assuming that most school administrators will not conduct cost-analysis studies themselves but instead may work with consultants or evaluators who do. Still, the administrator needs to be able to understand the methods sufficiently to make decisions based on the results as well as to explain his or her decisions to others. After describing the four methods, we offer guidelines, suggestions, and references for doing cost studies.

Cost-Analysis Methods

The four formal cost-analysis methods seen as having the greatest usefulness in education are cost-feasibility, cost-utility, cost-benefit, and cost-effectiveness analyses (Levin, 1981). The first method, cost-feasibility analysis, is useful for determining whether a program is affordable within budgetary constraints. The last three methods enable you to combine outcomes with costs to determine the most cost-efficient program. Levin (1981, 1983) provides an excellent introduction to the use of these four methods.

First a method to determine budget feasibility; three methods combine outcomes, costs to determine most cost-efficient program

We will first discuss each cost-analysis method and then apply it to the same hypothetical educational problem to help you compare the differences in the methods. The problem concerns a computer skills training course for high school seniors, for which two alternative ten-week instructional programs are being considered. Program A involves teaching 20 students five hours weekly in the programming language BASIC at a community college microcomputer laboratory across town. Each student is to have a personal microcomputer for use during classroom hours and access to the laboratory's programming consultant as well as to the special computer instructor hired for the program. Program B is offered by the computer instructor to the 20 students at the high school and involves intensive workbook exercises in three different computer languages. In addition to four hours of weekly instruction, these students will receive one-hour weekly "hands-on" experience scheduled on the high school's single microcomputer. We will return to this problem to illustrate each of the four methods.

Cost-Feasibility Analysis

Cost-feasibility analysis estimates the cost of a program or of alternative programs to see whether the program or which of the alternatives are possible within existing financial resources. You simply determine the

cost of various components of each alternative and then compare total costs with the amount of resources available. Cost estimates might be the costs projected before programs are actually implemented, or tabulations of actual costs incurred by existing programs. Cost-feasibility does not deal at all with program outcomes, and therefore provides no way of combining costs and outcomes in an overall analysis.

Cost-feasibility methods are most appropriate when program outcomes can be assumed to be equivalent or when decision makers consider program outcomes to be irrelevant. For example, one cost-feasibility study conducted in Oregon determined the costs of owning a bus transportation system versus contracting for bus transportation services. The school district assumed that both alternatives would provide equivalent transportation services and so outcomes were not measured (J. K. Smith, 1983). The problem with most cost-feasibility studies, however, is that summarizing costs without considering outcomes results in knowing which of several alternatives is cheapest, without knowing whether any of them produce the desired results.

Cost-feasibility methods are most appropriate when program outcomes are equivalent or irrelevant

In the case of the computer training programs, cost-feasibility is simply determined by estimating the expected (or actually incurred) costs of each alternative. The total cost is calculated by identifying all the components (ingredients) needed to run each program, determining the cost of each

Table 1

Cost Estimates* of Two Computer Skills Training Programs

	Program A		Program B	
Personnel	Computer Instructor ($80/day x 5-day/wk x 10 wks)	$4000	Computer Instructor ($80/day x 5-day/wk x 10 wks)	$4000
	Programming Consultant ($20 per hour x 5 hrs x 10 wks)	$1000		
Facilities	Rent of microcomputer laboratory and machines ($48 per hour x 5 hr/wk x 10 wks)	$2400		
Materials	Computer Manuals ($10 per manual x 1 language x 3 manuals x 20 students)	$ 600	Computer Manuals ($10 per manual x 3 languages x 3 manuals x 20 students)	$1800
			Workbook ($3.33 per workbook x 3 workbooks x 20 students)	$ 200
Transportation	Bus to Microcomputer Laboratory ($20 per trip x 10 trip/wk x 10 wks)	$2000		
Total		$10,000		$6,000

*Only program costs in addition to normal school costs are included here, a full cost listing would include all costs (e.g., even cost of "rent" on program use of classroom, etc.).

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ingredient (valuing), and summing the costs. Table 1 contains a sample cost summary for the two programs. The total costs are estimated to be $10,000 for Program A and $6,000 for Program B. At 20 students per class, the cost per student is $500 in Program A, and $300 in Program B. Which program alternative is feasible depends upon the budget allocation for the course. Most likely, the administrator would select Program B, since it is the less expensive option.

In contrast to cost-analysis methods, traditional educational evaluation studies examine outcomes without attention to costs and can result in selecting a program alternative that is only marginally more effective, but considerably more expensive than other alternatives. New instructional technologies often fall into this latter category. In our computer training cost-feasibility example, we can see that examining only costs tells us nothing about the outcomes of either alternative. Only by incorporating both costs and outcomes within comparative studies of program alternatives can one reliably determine which alternative is more effective for a given cost, or how much it would cost to obtain a desired level of outcome. The following three techniques allow us to combine both costs and outcomes in a single analysis.

Cost-Utility Analysis

Cost-utility analysis goes one step further than cost-feasibility and estimates the probability of the expected outcomes of each alternative. In this method, no actual outcome data are collected, but rather estimates of outcomes are projected. This analysis is helpful when outcome data are unavailable, but some assessment of probable outcome is possible and desirable. One problem with cost-utility analysis is that the measures and analysis are not based on actual measures of outcome, consequently, the results will usually differ, depending on who does the analysis. This form of analysis is useful as a planning tool for administrators when funds for a formal evaluation are not available, when time constraints prohibit a lengthy data collection process, or as an aid in group discussions of possible program effects.

Cost-utility analysis is useful as a planning tool when funds for a formal evaluation are not available

Cost-utility analysis can readily be applied to our computer training course example. First, we already know that Program A costs $500 per pupil and Program B costs $300 per pupil. However, we have no indication which program is more effective. Cost-utility analysis provides a systematic way to estimate the probable outcome of each alternative. The steps of a cost-utility analysis of the computer training alternatives are listed below and summarized in Table 2.

1. Estimate the probability of desired outcomes for Program A and Program B. Assume in this case that the expected outcome is an increase of five points on a standardized test of computer programming skills. For Program A, a 60 percent chance of such an increase is anticipated because of the extensive time spent on the machines, while for Program B only a 20 percent chance of such an increase is expected (See Table 2). Estimates of probable out-

Table 2

Cost-Utility Analysis of Two Computer Training Programs

	Program A	Program B
Probability of raising computer programming test scores by 5 points	.6	.2
Utility of raising computer programming test scores by 5 points	6	6
Expected utility	(.6)(6)=3.6	(.2)6=1.2
Cost per pupil	$500	$300
Cost-utility ratio	$500/3.6=$138.80	$300/1.2=$250.00

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comes can be based on prior knowledge of similar programs, consensual agreement among knowledgable individuals, an average rating of a number of staff, or even a single individual's estimate.

2. Place an importance or utility value (usually based on a 10-point scale, with 10 representing the highest value) on the estimated outcomes. In our example, we judged that the utility of raising the computer programming test scores was the same for each program and gave it a value of 6.

3. Calculate the expected utility of each program by simply multiplying the expected outcome by its utility. As illustrated in Table 2, the expected utility for Program A is three times that of Program B (3.6 versus 1.2).

4. Compute the cost-utility ratio by dividing the cost by the expected utility. In our example, the cost-utility ratio for Program A is $138.80 (500/3.6) and the cost-utility ratio for Program B is $250.00 (300/1.2).

The decision maker would probably select Program A as the best alternative. Given its higher probability of achieving a five-point gain, Alternative A is the most cost efficient and the best use of resources in spite of its higher cost.

Cost-Benefit Analysis

Cost-benefit analysis is based on objective outcome measures which can be expressed in terms of dollars. Therefore, it provides replicable results and enables you to compare not only alternatives for a given program, but even alternative programs which have different outcomes. Because all outcomes are expressed in common terms (dollar benefits), one can compare reading programs with counseling programs with athletic programs. The major problem with using cost-benefit analysis in evaluations of instructional programs is the difficulty and meaningfulness of assigning dollar values to program outcomes. Parents and educators alike are skeptical about dollar values assigned to such outcomes as increased music appreciation, reading comprehension, self-confidence, or math skills, and may consider cost-benefit analysis as inappropriate for programs with these outcomes.

A cost-benefit analysis can be applied to our computer training example. Assume that both computer training programs have been in effect for several years, each in a different high school. Because of the recent push for vocational training, administrators are interested in the differential earning powers of students from the two programs. We already know that Program A costs $500 per pupil and Program B costs $300 per pupil. We can compare the yearly income of a sample of recent graduates of both programs to the income of students who did not participate in either program. Assume that we find graduates from Program A earned an average of $400 more a year and graduates from Program B earned an average of $600 more a year than the comparison group of graduates who participated in neither program. We might suspect that Program B graduates earned more than Program A graduates because they knew a wider range of programming languages than Program A students. (In this example, we are looking at only starting pay differences and so did not estimate life-long income. There are standard economic methods for estimating life-long income, but those methods go beyond the scope of this paper and are not discussed here.)

The cost-benefit ratios for this example can be found by dividing the cost per student by the benefit for each student (see Table 3). In this case, the cost exceeded the benefit in Program A ($500/$400); it cost $1.25 in program funds to increase each student's income by $1.00. The cost-benefit ratio ($300/$600) from Program B, however, shows that the benefits are twice that of the cost: it cost only 50¢ in program funds to increase each student's income by $1.00. Net benefit, or the amount of benefit accrued beyond the cost, can be calculated by subtracting cost from the benefit. For Program A, the net benefit is -$100 per student, while for Program B, it is $300 per student. Based on the cost-benefit

Table 3

Cost-Benefit Analysis of Two Computer Training Programs

	Average Cost Per Student	Average Benefit Per Student	Cost/Benefit Ratio	Net Benefit Per Student
Program A	$500	$400	500/400=1.25	-$100
Program B	$300	$600	300/600= .50	+$300

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ratio and the net benefits, Program B is clearly the better of the two alternatives if one is interested in increasing student income after graduation. Program B's overall cost is less and its benefits are greater.

Program B is clearly better if one wants to increase student income after graduation

Cost-Effectiveness Analysis

Cost-effectiveness analysis consists of representing program outcomes, not in terms of dollar units, but in terms of other effectiveness units, such as reading scores, attitude scores, behavioral ratings, and so on. Many of these effectiveness measures are the standard outcome measures currently used in educational evaluation. Because you do not convert all outcomes to the same unit (i.e., dollars), you cannot use cost-effectiveness analysis to compare across programs (e.g., to compare reading programs to athletic programs). Generally, however, this has not been a problem in educational evaluation, since such comparisons have been of less interest than comparisons between program alternatives, such as which of two instructional strategies most effectively improve reading scores.

Let us now apply cost-effectiveness analysis to our computer training programs. The program costs are the same as in the preceding examples. Suppose we obtain a measure of effectiveness by administering a standardized test of general computer programming skills at the beginning of each course (pretest) and at the end (posttest). The effectiveness of the two programs can then be compared by seeing how much the students gained (posttest - pretest). Suppose students in Program A gained an average of 20 points on the test, while students in Program B gained only an average of 5 points. When the program cost is divided by its effectiveness (i.e., its average test score gain) for each alternative, it is clear that Program A, although the most expensive alternative, costs less per point gain (see Table 4). That is, each point gain in Program A costs $25 ($500/20), compared to each point gain on Program B which costs $60 ($300/5). The decision maker would likely pick Program A as the best alternative based on this analysis, which looks only at increases in test-measured programming skills. The calculations for this analysis are summarized in Table 4.

Discussion

The results of the preceding examples are summarized in Table 5. As you can see, we have applied four methods of cost-analysis to

Applying four methods to same program results in different conclusions

the same program and come up with different conclusions. The cost-feasibility and cost-benefit analyses point to Program B as the best alternative to select (it is cheaper; it contributes to increases in student income), while cost-utility and cost-effectiveness analysis point to Program A as the best alternative (it has a higher probability of success; it contributes to increased student programming skills). One possible reason for these discrepant results in this example is that Program A, with its more intensive hands-on training, results in higher performance on the standardized test. When it came to the students receiving a higher paying job, however, Program B came out ahead because students were exposed to more computer languages, and could apply for a wider range of computer jobs.

We have constructed these examples to demonstrate the importance of selecting the

Table 4

Cost-Effectiveness Analysis of Two Computer Training Programs

	Cost Per Pupil	Effectiveness (Increase in test scores)	Cost-Effectiveness Ratio
Program A	$500	20 points	$500/20 = $25
Program B	$300	5 points	$300/5 = $60

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Table 5

Comparison of the Four Cost-Analysis Methods When Applied to the Two Computer Training Programs

Method	Program	Cost Per Student	Outcome	Ratio	Select	Interpretation
Cost-Feasibility	A	$500	—	—		Costs more than available budget
	B	$300	—	—	B	Costs less than available budget
			Expected Utility			
Cost-Utility	A	$500	3.6*	$500/3.6=$138.80	A	Has a higher probability of success
	B	$300	1.2*	$300/1.2=$250.00		Has a lower probability of success
			Dollar Benefit			
Cost-Benefit	A	$500	$400	$500/400=$1.25		Each $1.00 earned costs $1.25
	B	$300	$600	$300/600=$ .50	B	Each $1.00 earned costs $0.50
			Test Score Gain			
Cost-Effectiveness	A	$500	20	$500/20= $25	A	Each point gain costs $25
	B	$300	5	$300/5= $60		Each point gain costs $60

*See Table 2 for the derivation of these figures.

proper cost-analysis method. In most cases, instructional methods or programs are not intended to affect directly a student's income but rather are intended to facilitate future learning and school performance. For example, a cost-benefit analysis of third-grade reading instruction methods would not only be difficult, but usually irrelevant to the instructional questions of importance. In contrast, a cost-effectiveness analysis of the reading instruction methods would be highly appropriate.

We have constructed these examples to demonstrate importance of selecting proper cost-analysis method

We believe that, for the majority of educational evaluations, cost-effectiveness analysis is the best cost-analysis method to use when a full evaluation is possible. Only for vocationally-oriented programs where the goal is to improve student marketability or job performance would cost-benefit analysis be the preferred method. For our computer training program example, either cost-effectiveness or cost-benefit analysis is appropriate. In selecting which method to use, the administrator would have to assess carefully whether test performance or income was more important, and then use the method which incorporates that outcome. Generally, this decision is made prior to the cost analysis and only a single analysis is conducted, but as we have illustrated, one could conduct both analyses in order to make a more informed decision.

To summarize, cost-feasibility analysis should be used when determining whether a program is economically feasible under budgetary constraints. No outcome data are taken into account using this method, and consequently there is no evidence to suggest which program is more effective. Cost-utility analysis goes one step beyond cost-feasibility and adds estimates of program outcomes. Because the outcome data are estimated rather than actually measured, however, the procedure is not reliable but may be helpful in planning situations. Cost-benefit analysis places a dollar figure on program outcome which is then compared to the cost of the program. It is often difficult to value educational outcomes in dollar terms and, as a result, the usefulness of this method is generally limited to vocationally-oriented instructional programs. Finally, cost-effectiveness analysis involves collecting data on program effects using traditional evaluation measures. These measures are then compared to the cost of the alternatives. Cost-effectiveness analyses are appropriate for evaluating programs with identical or similar outcome measures. Of the four techniques, we recommend cost-effectiveness analysis as the best method for use in the evaluation of alternative instructional programs.

A few aids are available for those administrators interested in learning more about cost-analysis procedures. We have developed a comprehensive checklist for planning, designing, conducting, and reporting a cost-effectiveness study. The checklist can also be used in reviewing past cost-effectiveness studies as well. The entire checklist is too long to reproduce here, but a free copy may be obtained by writing the second author of this paper. We have also listed a few helpful readings in the references which follow to help you pursue these methods further.

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As you can see from our examples, the differences between the four major types of cost-analysis methods are clear and easy to understand. While conducting a cost analysis study can require considerable time, effort, and expertise, you already have a sufficient understanding of the basic approaches to begin considering the use of formal cost studies in your own setting. Who knows, with help from some evaluation and business office staff, there may be a cost study or two in your future. Good luck!

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Research on Evaluation Program reports are available from Judy Turnidge, Research on Evaluation Program, Northwest Regional Educational Laboratory, 300 S.W. Sixth Avenue, Portland, Oregon 97204.

(Editor's note: Jana Kay Smith, Evaluation Specialist, and Nick L. Smith, Director, are with the Research on Evaluation Program of the Northwest Regional Educational Laboratory. This paper results from a series of research activities designed to adapt cost-analysis techniques for evaluative uses. The work reported herein was supported in part by the National Institute of Education through Contract No. 400-80-0105 to the Northwest Regional Educational Laboratory. It does not necessarily reflect the views of either agency, however, and no endorsement should be inferred.)

PROJECTED COSTS

		TOTALS
Salaries and Benefits		
Director/Teacher @ .8FTE*	13,747.10	
Aide @ .8FTE*	8,280.00	
		22,027.00
Consultants		
Evaluator		
Title I outcome evaluation	2,700.00	
Process evaluation of program	1,800.00	
Reading Specialist		
7 days consulting @ $100/day	700.00	
Travel expenses (mileage @ 15¢/mile)	69.90	
		5,269.90
Travel		
Title I teacher attends National Reading Association Conference in San Francisco, Feb. 4-7		
Per diem	160.00	
Travel	420.00	
		580.00
PAC Activities		
Needs Assessment	450.00	
Attendance at state Title I conference	75.00	
Arrangements for 2 open meetings	55.00	
PAC consultants (2 for 1 day @ $60/day)	120.00	
		700.00
Materials		
Books		
4 copies each of assorted reading books for 2-5 grade readers (list available upon request)	100.00	
5 sets--Special Reader's series	300.00	

*The other .2FTE for the teacher and aide are spent with the Title I Math project.

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Projected Budget-page 2

Tapes/Films/Filmstrips		
Filmstrips with the Special Reader's series	380.00	
Films of episodes in four books purchased last year	80.00	
Videotapes for plays put on by students	140.00	
Supplies and Copying		
Scissors (15 pairs)	7.50	
Paper	80.00	
Photocopying	30.00	
Construction paper	100.00	
Ditto masters	20.00	
Tests		
Comprehensive Achievement Battery-100 tests fall and spring, plus publisher's scoring	150.00	
Reading Diagnostic Test 150 tests	75.00	
150 student report forms	25.00	
Informal test booklets for the Special Reader's series	25.00	
		1,512.50
Equipment		
Reading resource console	725.00	
Videotape machine	1,086.50	
Replacement of 2 reading machines @ $550 each	1,100.00	
		2,910.50
TOTAL PROJECT	33,000.00	33,000.00

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COST ESTIMATION WORKSHEET

BUDGET CATEGORY	COST	TOTAL
Salaries + Benefits Director/Teacher Aide		
Consultants		
Travel		
PAC Activities		

BUDGET CATEGORY	COST	TOTAL
Materials		
Audio-visual		
Supplies + Copying		
Tests		

BUDGET CATEGORY	COST	TOTAL
Equipment		
Building		
Other		

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* taking error band into account

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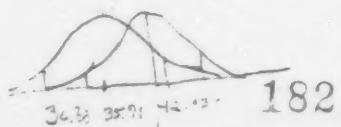
COST EFFECTIVENESS RATIO

** EXAMPLE 1 **

	ALTERNATIVE	
	A	B
Estimated total project cost	$33,000.00	$33,000.00
Estimated number served	77/10	77/10
Estimated average cost per student served	$428.57	$330.00
Estimated improvement in achievement caused by Title I	12 points ±1.9 / ±5.3	8 points ±1.9 / ±5.3
Cost effectiveness ratio = (avg. cost per student) / (avg. achievement improvement) = dollars spent per unit improved achievement	$35.71* 42.93 − 37.22	$41.25 38.10 − 33.53

*Therefore, Alternative A is more cost effective here.



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COST EFFECTIVENESS RATIO

** EXAMPLE 2 **

	Alternative	
	A	B
Estimated total project cost	$33,000.00	$33,000.00
Estimated number served	77	100
Estimated average cost per student served	$428.57	$330.00
Estimated improvement in student achievement caused by Title I	15 points	15 points
Cost effectiveness ratio = (avg. cost per student) / (avg. improvement in attitude) = dollars spent per unit improved achievement	$28.57	$22.00*

*Therefore, alternative B is more cost effective here.

EXERCISES

Instructions: Described on the following pages are six situations. For each situation, answer all of the questions listed below. Select a spokesperson who will report your conclusions to the rest of the group.

1. What program alternatives are being considered?

2. What cost analysis method seems most appropriate (cost feasibility; cost utility; cost benefit; cost effectiveness)?

3. What pragmatic factors might affect the conduct of the analysis?

4. What political factors might affect the conduct of the analysis and/or the use of the results in decision making?

5. Given the pragmatic and political factors you listed in questions 3 and 4, do you still think the cost analysis method you chose in question 2 is most appropriate? If not, what else would you suggest?

6. Briefly outline the steps of your analysis and include a description of your outcome measures (if appropriate).

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1. Over the past several years, NCE gains for the elementary school Chapter 1 mathematics program in a large urban district have been disappointingly low. In response to these results, the Chapter 1 program staff identified two new programs for consideration. They decided to pilot test both programs to help them decide which should be adopted by the district. Two schools with comparable student populations and a Chapter 1 program in grades 2-4 were selected to pilot test the two programs. Program A resulted in a project gain of 6 NCES, while Program B yielded a gain of 2 NCES. The costs of the two programs were $300 per pupil for Program A and $75 per pupil for Program B.

2. The school board is concerned about the costs of bus service which have continued to rise despite declining student enrollment. They are considering the following 3 alternatives: (1) continue to provide bus service; (2) contract with an independent bus service; and (3) eliminate bus service.

3. In order to qualify for federal funding under P.I. 94-142, local school districts must invest a substantial portion of their locally generated revenues to provide educational services to handicapped children. In turn, this education is believed to help these students find jobs and thus reduce the cost of unemployment and social services, and help make handicapped people more self-sufficient.

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4. A state department of education had a five year contract with the federal government to provide teacher training assistance to school districts in its state. The contract had a provision that allowed the government to cancel the contract. A number of similar contracts with other state departments of education had recently been cancelled. Project administrators were debating whether or not to start a new training program that would take three years to complete.

5. A state funded compensatory education program provides funding in the amount of $200 per qualifying pupil in grades 1-6. Recent test results indicate that the pupil shows substantial success in the primary grades (1-3) while only limited success in grades 4-6. The state legislature is planning to provide additional funds for this program, but first wants the Department of Education to provide information as to how those funds could best be spent.

6. A state is considering the building of ten regional vocational technical training centers at a cost of about $5.5 million each. Before going through with these plans, state decision makers have asked the Department of Education to provide them with information indicating that the costs of the program will be justified through measures such as increased earning potential and better employment prospects for vocational/technical graduates.

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